

6161 YR 29/2



Final Quality Assurance Project Plan

Fort Devens, Massachusetts

Volume II Standard Operating Procedures

Submitted to

U.S. Army Environmental
Center (USAEC)
Formerly USATHAMA
Aberdeen Proving Ground, Maryland

Revision 0
June 16, 1993

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Arthur D. Little, Inc.
Acorn Park
Cambridge, Massachusetts
02140-2390

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DAAA15-91-D-0016

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Project Plan**

Arthur D Little

**Fort Devens,
Massachusetts**

**Volume II
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Date: April 29, 1993
Revision No.: 2
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SAMPLE CUSTODY

Written By:	Approved By/Date:	QA Concurrence/Date
A. Kronick	<i>Mark O. Hedges</i> 4/30/93	HILTON RIVER 4/30/93

This SOP contains 5 Sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 References
- 4.0 Associated SOPs
- 5.0 Procedure

1.0 Purpose

The purpose of this SOP is to ensure the safety and integrity of samples that are transferred from the one location (ie. field) to another (ie. laboratory).

2.0 Application

This procedure applies to all environmental samples collected by employees of Arthur D. Little, Inc.

3.0 References

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, USEPA, SW-846, 3rd Edition, June 1990.

4.0 Associated SOPs

ADL-1002 Sample Receipt and Log-In.

5.0 Procedure

5.1 Field Staff.

- 5.1.1 Identify procedures (preservatives, sample containers, sample storage requirements) to safeguard sample integrity.
- 5.1.2 Identify and document sample control actions and documentation required.
- 5.1.3 Record details of sampling operations, including field support activities, in a bound laboratory notebook.
- 5.1.4 Prepare and attach to each sample, as soon as it is collected, at least one label clearly and uniquely identifying the collected sample. An example label is shown as Attachment 1 to this SOP.
- 5.1.5 After filling a sample container, apply a chain-of-custody (COC) seal that will unequivocally reveal any possible tampering with the sample. Sign and date the seal.
- 5.1.6 Prepare a field chain-of-custody (COC) record for each (batch of) samples as shown in Attachment 2 of this SOP.
- 5.1.7 Maintain samples under controlled conditions (refrigerated, dark, secure) in the field prior to shipment.
- 5.1.8 Sign and date the COC record each time control of field samples is transferred. (This includes transfers of custody between individuals in the field as well as transfers from field personnel to transporters or other parties.)
- 5.1.9 Transmit two copies of the signed field COC document with the samples and obtain a copy of the way bill and/or bill of lading when using a commercial carrier. Retain the original copy of the COC document and attach the copies of the way bill and/or bill of lading.

5.2 Laboratory Staff

- 5.2.1 Follow procedures defined in SOP ADL-1002 for sample receipt and log-in.
- 5.2.2 Review laboratory COC document (Attachment 3) at time samples are received for analysis. confirm numbers and identities of samples received.

Confirm that an SOP for the requested analysis has been specified. In the case of discrepancies, consult the Quality Assurance Coordinator.

- 5.2.3 Sign and date the laboratory COC form to document receipt of the samples.
- 5.2.4 Store any samples not in active use under conditions specified by the SOP.
- 5.2.5 When transferring samples to custody of another staff member (e.g., from sample preparation laboratory staff to analysis staff), both sign and date the laboratory COC form.
- 5.2.6 Upon completion of a laboratory operation, return residual samples and/or extracts to the sample custodian. Document the transfer on the laboratory COC form.
- 5.2.7 When all laboratory work on a sample has been completed, return the complete laboratory COC form to the sample custodian.

5.3 Data Reduction and Review Staff

Obtain copies of the laboratory COC form from the Sample Custodian. Sign and date the appropriate lines of the form to indicate primary responsibility for data reduction, reporting, and/or quality assurance review.

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Date Initiated: August 8, 1990
Revision No.: 2
Revision Date: February 25, 1993
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ATTACHMENT 1. EXAMPLE SAMPLE LABEL

Arthur D. Little, Inc.

Acorn Park
Cambridge, MA 02140
(617)864-5770

Sample #

Analysis

Preservation

Collectors

Date

Time

Arthur D. Little, Inc.

Acorn Park
Cambridge, MA 02140
(617)864-5770

Sample #

Collectors

Date

Time

ATTACHMENT 2. FIELD CHAIN-OF-CUSTODY FORM

Arthur D Little

SOP No.: ADL-1002
Date Initiated: January 18, 1989
Revision No.: 1
Revision Date: April 16, 1990
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SAMPLE RECEIPT AND LOG-IN

Written By:	Approved By:	Date	QA Concurrence	Date
<i>Cybil Wille</i>	<i>Paul</i>	4/17/90	<i>Judith C. Harris</i>	4/17/90

1.0 PURPOSE

The purpose of this SOP is to ensure that all samples are processed promptly upon receipt, that chain-of-custody documentation is maintained, and that any sample damage or discrepancy is promptly recorded and reported.

2.0 APPLICATION

This procedure applies to all field samples received at the Arthur D. Little Acorn Park facility.

3.0 REFERENCES

None.

4.0 ASSOCIATED SOPs

ADL - 1001 Sample Custody

5.0 PROCEDURE

5.1 Responsibility

All steps in this procedure are the responsibility of the Sample Custodian, except as noted.

Arthur D Little

5.2 Preparation for Sample Receipt

- 5.2.1 Program Manager/(Sub)Case Leader: Identify number and types of samples and the analyses required.
- 5.2.2 Program Manager/(Sub)Case Leader: Notify Sample Custodian, Laboratory Supervisor(s) and Quality Assurance Coordinator of pending sample receipt.
- 5.2.3 Inform shipping room personnel of scheduled arrival of samples. Develop special receiving instructions and ensure staff availability, if necessary, for anticipated after-hours or weekend delivery.
- 5.2.4 Identify secure, suitable location, if necessary, for temporary storage of samples prior to entry into the sample management system.

5.3 Sample Receipt

- 5.3.1 Obtain all relevant air way-bills and other shipping documents, File in chain-of-custody record.
- 5.3.2 In a bound laboratory notebook, document date and time of receipt, condition of shipping containers, seals and notes.
- 5.3.3 Retrieve and review chain-of-custody documentation accompanying the samples.
- 5.3.4 Break and/or remove outer seals (if any) and recover samples from shipping containers.
- 5.3.5 Visually inspect each sample to determine condition upon receipt. Record any evidence of container breakage, leakage, or tampering in the laboratory notebook and on the chain-of-custody record. Include visual observations of proper temperature maintenance such as "ice still present", "samples still frozen", etc. If any evidence of breakage, leakage or tampering is observed, notify the Program Manager/(Sub)Case Leader immediately.
- 5.3.6 Cross-check sample containers against chain-of-custody documents. Record any discrepancies in the laboratory notebook and on the chain-of-custody record. If any discrepancies are noted, inform the Program Manager/(Sub)Case Leader immediately.
- 5.3.7 Sign and date the notebook and the chain-of-custody document. File one copy of the chain-of-custody record and return a second copy to the shipper.
- 5.3.8 Program Manager/(Sub)Case Leader: If breakage, leakage, tampering, or discrepancies are reported by the Sample Custodian, notify the client (or client's designated representative) within 24 hours (or the next business

day), unless alternative notification procedures have been specified by the client.

5.4. Initial Sample Storage and Lot Assignments

5.4.1 Store samples under conditions required by analysis SOP(s) until logged-in and labelled.

5.4.2 Notify Laboratory Supervisor(s) of receipt of samples. Determine their current requirements for assignment of samples to lots.

5.4.3 As directed by the Program Manager/(Sub)Case Leader and/or Quality Assurance Coordinator, take aliquots of samples to be analyzed by multiple procedures.

5.4.4 Intersperse laboratory QC samples, as instructed by the Quality Assurance Coordinator, into the sample batch.

5.5 Generic Sample Log-In

5.5.1 Assign a unique laboratory code to each sample, including QC samples. If aliquots are taken for multiple analyses, assign a unique laboratory number to each aliquot.

5.5.2 Log samples into the laboratory sample management system, including:

- Field Sample Code
- Laboratory Identification Code
- Date of Sample Collection
- Time of Sample Collection
- Name (or other appropriate identification) of person who collected the sample
- Date of Sample Receipt
- Type of Sample (Sample Matrix)
- Analyses Requested
- Comments indicated by field or laboratory notes

5.5.3 Generate laboratory chain-of-custody forms.

5.5.4 Deliver samples and laboratory chain-of-custody forms to designated laboratory personnel if immediate analysis is required. Otherwise, place samples in secure storage and file laboratory chain-of-custody forms pending analysis.

5.6 USATHAMA Sample Log-In

5.6.1 Access Sample Log-In Program (currently on Compaq 386S PC).

- From LeMenu, select "D" for DBase IV
- Select "L" for USATHAMA log-in. The log-in menu should be displayed.

5.6.2 Select "1" to log-in new samples to specific lots. Respond to menu options:

- Option 1: Add new samples to existing lot
- Option 2: Open new lot: designate analysis and matrix required (e.g., "1" for semivolatiles in water, "14" for explosives in soil).
- Option 3: Specify/add delivery order number or client name
- Option 4: Specify/modify class of QC required. This automatically generates QC sample numbers for lot.
- Option 5: Specify/modify analytes of interest (all or selected analytes) for delivery order.

5.6.3 Log-in screen will now appear with lot number. For first sample, type in:

- Field number
- Date collected
- Collector
- Date received
- Sample Custodian
- Field notes (if any)
- Lab notes (if any)
- Delivery Order number

5.6.4 Respond to menu options:

- Option 1: Continue to next sample.
- Option 2: If no more samples, keep lot open or close lot by typing "no"

5.6.5 To close a lot:

- Select "2" to close a lot (if not already closed)
- Select "5" to print laboratory chain-of-custody form
- Select "6" to print sample distribution sheet (2 copies: 1 for lot package and 1 for delivery order notebook)
- Select "8" to print labels.

5.6.6 When lot is closed, verify that lot package is complete and includes:

Signed and dated laboratory chain-of-custody form
Sample distribution sheet
QA checklist
Copies of relevant field chain-of-custody forms

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5.6.7 Label sample bottles and store under conditions required by analysis SOP until analyst is ready for samples. Upon request, deliver lot package and sample bottles to analyst.

6.0 PROFICIENCY MEASURE

Demonstrate proficiency in this procedure by performing the procedure in the presence of a person previously certified.

Document proficiency by completing the attached certificate.

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CHEMICAL SCIENCES SECTION

Certificate of Proficiency

This Certifies That

(Name)

Has Demonstrated Proficiency In

(Method No./Title)

___ According to the procedures specified in the SOP

___ According to the procedures described below

By: _____
(Signature)

(Printed Name)

SAMPLE AND EXTRACT STORAGE

Written By:	Approved By/Date:	QA Concurrence/Date
A. Kronick	<i>Kronick E Rice</i> 4/30/93	<i>HAIGUN RIVIS, RD</i> 4/30/93

This SOP contains 5 Sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 References
- 4.0 Associated SOPs
- 5.0 Procedure

1.0 Purpose

The purpose of this SOP is to describe the storage of standards, samples, and sample extracts for volatile and semi-volatile analytes.

2.0 Application

This procedure applies to all volatile and semi-volatile environmental samples.

3.0 References

None

4.0 Associated SOPs

None

Note: This is a reissue of the SOP originally numbered C002.

5.0 Procedure

5.1 Volatiles.

- 5.1.1 Store samples for VOA analysis in the refrigerator in a dedicated refrigerator labeled "VOA Samples" prior to analysis. Store remaining samples for one year following data submission.

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Date Initiated: February 2, 1989
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5.1.2 Store standards for VOA analysis in a dedicated refrigerator/freezer that is labeled "VOA Standards".

5.2 Semi-Volatiles

5.2.1 Store samples for semi-volatiles analysis in a cold room/refrigerator prior to extraction.

5.2.2 Store extracts for semi-volatile analysis in a dedicated refrigerator labeled semi-volatile extracts prior to analysis. Store remaining extract in a freezer for one year following data submission.

5.2.3 Store semi-volatile standards in a labeled standards refrigerator.

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Date: June 16, 1993
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FIELD DECONTAMINATION OF SAMPLING EQUIPMENT

Written By:	Approved By/Date:	QA Concurrence/Date:
J. Rice	<i>[Signature]</i> 6/16/93	<i>[Signature]</i> 6/16/93

1.0 Purpose

The purpose of this Standard Operating Procedure (SOP) is to provide field personnel with step-by-step procedures to be used for the field decontamination of sampling equipment.

2.0 Application

The procedure in this SOP is applicable to the decontamination of sampling equipment and to be used for the collection of samples for organic or inorganic analyses.

Water used for rinsing field equipment shall be bottled distilled water or water from a USATHAMA-approved source. Such approved water should originate from an uncontaminated (background) and untreated source. The water shall be analyzed by a USAEC performance demonstrated laboratory for all project specific analytes prior to collection of field samples. Water from chemical supply companies or retail merchants is acceptable, provided that analysis reveals such water is free of interferences. At least one sample must be submitted to the laboratory and be analyzed for all analytes of interest prior to the first use in the field. The initial rinse water analyses may be done prior to certification approval provided that the analytical procedures used are identical to those tested during certification. A rinse blank shall be included in the initial lot of samples during the initial and subsequent sampling excursions, defined as the time between mobilization and demobilization of the sampling team. Additional rinse blanks shall be taken, as required. Waivers of these requirements will be considered by USAEC Chemistry Branch on a case-by-case basis.

In no instance shall detergents, soaps, or solvents be used to clean equipment in the field, unless specific permission is given by USAEC.

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2.1 Ground Water Equipment

All equipment used to measure and sample the ground water system (e.g., bailers, pumps, tapes, ropes) must be cleaned before use in each well to prevent cross contamination between wells. Equipment that is dedicated to a well site may not require cleaning between sampling events. If the well is free of inflowing sediments, thorough rinsing will be sufficient. When inflowing sediments adhere to equipment, scrubbing may be required in addition to rinsing.

3.0 References

Refer to specific Work Plan, Field Operations Plan and Quality Assurance Project Plans for details associated with the individual sampling event.

"Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports", Department of the Army, USATHAMA, March 1987.

4.0 Associated SOPs

None

5.0 Equipment

5.1 Equipment for Routine Decontamination

- Chemical resistant gloves - Latex, neoprene, etc. Refer to project specific Health and Safety Plan for requirements.
- Respirator - For use in enclosed areas.
- Potable water source.
- Container (5-gallon or more) with spigot for potable water.

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- Brushes - Type depends on the specific equipment to be cleaned, examples are:
 - Long-handled natural hair stiff bristle
 - Small test tube brush
 - Scrub brush
 - Etc.
- Distilled/deionized water source.
- Container (5-gallon or more) with spigot for distilled/deionized water.
- Large wash bucket and/or tub (5-gallon bucket and/or 1 1/2' x 3' x 6" tub); size is dependent on the type of equipment to be cleaned. The equipment must be easily manipulated for thorough cleaning in the wash tub or bucket.
- Squirt bottles - Teflon® for organic solvents and deionized distilled water - polyethylene for potable water.
- Stainless steel garden sprayer for aqueous rinsing of large pieces of equipment.
- Aluminum foil or Teflon® film.

5.2 For Heavily Contaminated Equipment

Additional decontamination equipment for sampling equipment heavily contaminated with organics, painted, rusted or coated with materials which are difficult to remove.

- Steam cleaner.
- Wire brushes.
- Sand blaster.
- Liquinox oralconox detergent.
- Methanol.

The specific decontamination equipment used is dependent on the type of equipment and what it is decontaminated with. Consult the Work Plan, Field Operations Plan, and Quality Assurance Plan for specific information.

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6.0 Decontamination Procedure

Outline

- Wash equipment with potable water.
- Rinse three times with potable water.
- Rinse with deionized and distilled water.
- Wrap with aluminum foil or Teflon® film until next use.

Step-by-Step Procedure

- 6.1** Don protective clothing. Ensure outer gloves are appropriate to handle both contaminated and decontaminated equipment. See project specific Health and Safety Plan.
- 6.2** Disassemble equipment as much as is practical (check with field team leader to determine the level of disassembly necessary). Small pieces are to be placed in a wash bucket or tub to soak to prevent loss and assist in the cleaning process.
- If equipment has been used to collect samples that contain large quantities of oil, grease or other hard to remove organic materials, it may be necessary to use solvents or detergent. This requires prior approval from USAEC Project Manager. If not, proceed to step 6.9.
 - In cases when equipment is painted, badly rusted, or coated with materials that are difficult to remove, it may be necessary to steam clean, wire brush, or sandblast equipment before proceeding.
 - If field equipment cannot be cleaned using procedures described below, it must not be needed.
- 6.3** Remove bulk amounts of the contaminant with paper towel, cloth towel or brush.

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- 6.4 Check areas of the equipment where contaminant may be caught (i.e., threads, corners, inner compartments of pumps or bailers, etc.).
- 6.5 Visually check to determine if a repeat of the above steps is necessary. If the majority of the contaminant has not been removed, repeat steps 6.3 - 6.5.
- 6.6 When the majority of the contaminant has been removed, proceed to step 6.7.

After initial pretreatment, if necessary, as described above, proceed with decontamination according to the following steps:

- 6.7 Wash equipment thoroughly with potable water using a brush to remove particulate material or surface film from all surfaces, threads, joints, corners, etc. A variety of brushes may be necessary to adequately remove the contaminants. Ensure that all disassembled parts have been cleaned.
- 6.8 Rinse all equipment parts thoroughly three times with potable water.
- 6.9 Rinse equipment twice with distilled, deionized water. (Note: If lesser quality water must be used, document this in detail in field notes).
- 6.10 Wrap the equipment (either separate parts or assembled) completely with aluminum foil or Teflon® film to minimize contamination during storage and/or transport.

Notes:

Decontaminated sampling equipment must never be allowed to become recontaminated prior to sampling. To avoid this, either decontaminate equipment immediately prior to use or protect decontaminated equipment by wrapping securely in aluminum foil which has been decontaminated by the above procedure. Good laboratory practices are adhered to at all times. Never allow "clean" equipment to come into contact with anything other than the sample, air or other "cleaned" equipment. This precludes contact with the ground (except for the actual sampling area), hands, clothing, or plastic bags, buckets, or trays, etc. Note, when aluminum foil, which has not been solvent rinsed, is used, that the "shiny" side was machined and is, thus, subject to machine oil contamination which this procedure may not remove. Only the "dull" side of aluminum foil should be placed facing sampling equipment.

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7.0 Safety Considerations

All field personnel will be briefed by the Field Team Leader before the conduct of the first sampling on the hazards and safe handling of sampling equipment that is potentially contaminated.

1. Wear chemical protective gloves (laboratory latex, if possible).
2. Wear safety glasses (most sun glasses and corrective glasses are not safety glasses).
3. Work in a well-ventilated area.
4. Use respirator in enclosed areas.

8.0 Documentation

The proper decontamination of sampling equipment must be recorded in the field notebook along with the date and time the procedure is completed.

9.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing the entire process a minimum of three times under the direct supervision of a senior consultant from the Earth Sciences and Engineering Unit (943), the Environmental Monitoring Unit (198), or his/her designee.

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COLLECTION AND HANDLING OF CHEMISTRY QUALITY CONTROL SAMPLES

Written By:	Approved By/Date:	QA Concurrence/Date:
<i>S. Tate</i>	<i>R. J. Lumb</i> 10-5-92	<i>Anthony M. Majors</i> 10-06-92

1.0 Purpose

This procedure describes the process for collection and handling of quality control samples associated with sediment and water sample collections for chemical analysis.

2.0 Application

This procedure applies to all field activities performed by Arthur D. Little and subcontractor/consultant staff which involve the collection of chemistry samples.

3.0 References

Refer to specific Field Survey Plans or Quality Assurance/Work Plans for scope of work associated with individual surveys.

4.0 Associated SOPs

ADL-1018 Operation of the Marble Water Sampler and Collection and Handling of Water Chemistry Samples.

ADL-1019 Collection and Handling of Subtidal Sediment Chemistry Samples from the Modified Van-Veen Grab Sampler.

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5.0 Procedure

5.1 Collection

Field quality control measures should include the preparation of various types of quality control samples. These may include field duplicates, matrix spike or matrix spike duplicates, equipment blanks, and field blanks. Consult individual Field Survey Plans or Quality Assurance/Work Plans for program-specific requirements of type and number of quality control samples to be collected. Quality control samples are handled as if they were true samples of the matrix they represent. All blanks are labelled and documented as are all other program samples.

5.1.1 Field Duplicate

Collection of duplicate field samples is conducted in accordance with the SOPs that the duplicates are to represent and handled, stored, labeled, and shipped as are all other representative samples of that type. Each field duplicate is an additional sample collected under the same procedures and in the same location as one field sample.

5.1.2 Matrix Spike or Spike Duplicate

Collection of matrix spike or spike duplicate samples is conducted in accordance with the SOPs that they are to represent. They are handled, stored, labeled, and shipped as are all other representative samples of that type. Each matrix spike or spike duplicate is an additional sample collected under the same procedures and in the same location as one field sample. These samples may be spiked in the field with pre-prepared spiking solution, or may be spiked in the laboratory according to program-specific requirements.

5.1.3 Equipment Blanks

Collected when sampling involves use of collection equipment which comes into direct contact with the sample (i.e. the modified Van-Veen grab). The equipment blank is representative of potential contamination associated with the equipment. After sediment chemistry samples have been collected, the grab is decontaminated according to the specifications in SOP ADL-1018. The grab is then rinsed inside

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with high-purity, de-ionized water and the rinsate is collected directly into a clean, pre-labelled water sample container. A decontaminated stainless steel funnel can be used to assist in the collection. The rinsate is the equipment blank. The equipment blank is preserved with 100 ml of methylene chloride and refrigerated at 4°C.

5.1.4 Field Blanks

This blank is representative of any atmospheric or other contamination that the field samples may be subject to and also of any potential contamination associated with the glassware. A clean, pre-labelled sample jar of the same batch used for sample collection is carried into the field, opened during the collection of one sample, and returned to the laboratory with the field samples. This blank will be stored under the same conditions as the field samples it is representative of.

5.2 Decontamination

All sampling equipment must be decontaminated before use at each station by the procedure outlined below. The grab must be decontaminated prior to sampling at each discrete station and prior to collection of the equipment blank. Equipment that remains on shipboard (e.g., scoops) must be decontaminated prior to each use.

1. Wipe clean with a sorbent pad, paper towel or rag, if necessary.
2. Rinse with de-ionized water.
3. Rinse with acetone.
4. Rinse with methylene chloride.
5. Rinse with acetone.
6. Rinse with de-ionized water.

Note: The solvent sequence may be modified on a project-specific basis. Consult the Survey Plan or Quality Assurance/Work Plan for survey-specific details.

If the sample equipment is used in areas of extreme petroleum contamination, it may be necessary to use new equipment at each sampling station until a more thorough decontamination can be performed using a detergent and water wash prior to the procedure above.

Decontaminated sampling equipment must never be allowed to become re-contaminated prior to sampling. To avoid this, either decontaminate equipment

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immediately prior to use or protect decontaminated equipment by wrapping securely in aluminum foil which has been decontaminated by the above procedure. Good laboratory practices are adhered to at all times. Never allow "clean" equipment to come into contact with anything other than the sample, air, or other "cleaned" equipment. This precludes contact with the ground (except for the actual sampling area), hands, clothing, or plastic bags, buckets, or trays, etc.

Note, when aluminum foil is used, the "shiny" side is machined and is thus subject to machine oil contamination which this procedure may not remove. Only the "dull" side of aluminum foil should be placed facing sampling equipment.

5.3 Handling of Samples

All blank samples for chemical analysis are inventoried and stored in a secure area under the same conditions as the sample matrix and analytical types they represent. Inventory includes counting all the samples to insure that all samples were collected and safely returned to the custody area on board, documenting all samples on Samples Collected Log forms, and preparing a Chain-of-Custody form for all samples. Refer to SOPs ADL-1016 and ADL-1017 for documentation and chain-of-custody procedures and requirements, respectively. At all times after collection, sample integrity and custody must be maintained. No compositing, mixing, stirring, or subsampling of the collected samples is to be performed in the field other than that described in this SOP.

The Chief Scientist is responsible for maintaining the custodial integrity of the samples until they are transported from the field. This is accomplished by the following means: a) the samples remain in the direct possession of the field personnel stored in a secured vessel (e.g., a controlled access freezer), or b) a tamper evidence seal (custody seal) is placed on any unsecured vessel (e.g., a cooler). When the Chief Scientist or his/her designate relinquishes custody of the sample to another party, the transfer of custody is documented on the appropriate Chain-of-Custody form. Custody seals are used on all shipping containers (i.e. coolers) to maintain custodial security while the samples are in the possession of a third party (eg. air freight courier).

Samples for chemical analysis have a limited holding time. Every effort is made to deliver samples to the analytical laboratory in a timely manner. The Chief Scientist is responsible for arranging sample pickup.

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5.4 Shipping of Hazardous Materials

When shipping containers of a hazardous material, check to see that packaging and labels comply with all applicable federal, state, and local regulations concerning the shipment of that material. Air freight courier personnel can assist in determining relevant regulations and compliance means. When shipping frozen chemistry samples packed in dry ice, the container must be vented (coolers should have a vent at the bottom on one end) and must bear a label which clearly states that the cooler contains dry ice and how many pounds, must bear the United Nations identification number (UN 1845) and the hazard classification (ORM-A).

6.0 Quality Assurance/Quality Control

Each survey team will be briefed by the Chief Scientist prior to the conduct of the first sampling on quality assurance measures of the sampling activities. All field personnel will be briefed on the potential for contamination and cross-contamination of samples and will be given guidance on techniques to avoid such problems. This includes the use of pre-cleaned sample containers; use of clean sampling equipment; use of the decontamination protocol in Section 5.3; and good laboratory practices in general.

7.0 Measure of Proficiency

It is the responsibility of each Chief Scientist to ensure that all sample collection is conducted according to established protocol and that all scientific personnel are appropriately trained and supervised. Problems unresolvable by the Chief Scientists are to be immediately brought to the attention of the Field Operations Manager or Case Leader.

8.0 Safety Considerations

This SOP requires the use of several hazardous chemicals. These include: acetone, methylene chloride, other solvents which may be specified for individual projects,

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and possibly dry ice. All field personnel will be briefed by the Chief Scientist before the conduct of the first sampling on the hazards and safe handling of these and any other chemicals on board.

Personnel should avoid direct contact with all chemicals and avoid breathing fumes. Contact with solvents will cause irritation of eyes, nose, throat, and skin. Acetone is extremely flammable. Methylene chloride is not flammable, but is a possible animal carcinogen. Dry ice is extremely cold, handling it can cause severe burns within seconds. Material Safety Data Sheets (MSDS) will be available on each vessel for each hazardous material on board. MSDS describe chemical properties, health hazards, and protection and safety measures. Refer to MSDS if unsure of the characteristics of a chemical. Follow these general guidelines when handling chemicals:

1. Wear rubber gloves (household or laboratory latex if possible).
2. Wear safety glasses (most sun glasses and corrective glasses are not safety glasses).
3. Work in a well ventilated area (on the open deck of ships, if possible).
4. Store chemicals securely and well padded.
5. Store chemicals away from living quarters and away from heat and ignition sources.

Waste solvents must be collected and disposed of separately from other waste streams. Collect all waste solvents in a compatible container which is clearly labelled as waste solvents. Hazardous waste should be stored safely on board, just as the other chemicals are and can be off loaded and disposed of on shore. Please refer to the Safety and Health Manual for further information.

WIPE SAMPLING

Written By:	Approved By/Date:	QA Concurrence/Date
M. Schreiber	<i>R. N. Hinkle</i> 3-25-93	<i>Mary Connell King</i> 3/26/93

This SOP contains 9 sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 References
- 4.0 Associated SOPs
- 5.0 Equipment
- 6.0 Decontamination
- 7.0 Wipe Sampling Procedure
- 8.0 Documentation
- 9.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to provide sampling and geotechnical field personnel with a set of guidelines, to insure proper collection of wipe samples.

2.0 Application

This SOP provides a step-by-step guideline to be followed by geotechnical field personnel responsible for performing or overseeing wipe sampling activities.

3.0 References

Smith, J.H., Chief, PCB Disposal Section, Chemical Regulation Branch, U.S. Environmental Protection Agency, "Wipe Sampling and Double Wash/Rinse Cleanup as Recommended by the Environmental Protection Agency PCB Spill Cleanup Policy", June 23, 1987.

4.0 Associated SOPs

ADL-4014

ADL-1009

5.0 Equipment

The following equipment is necessary for the proper collection of wipe samples:

- stainless steel 100 square centimeters template;
- sample vials containing pre-cleaned 3" x 3" surgical gauze pads pre-moistened with preservative or hexane, depending on analyte;
- sample labels and clear tape to cover the labels;
- tweezers or forceps to remove and replace gauze from and into sampling vials;
- metal ruler;
- coolers and duct tape to ship samples;
- bubble wrap, ziploc bags, and garbage bags to ship samples;
- all required documentation including a sufficient supply of the appropriate field forms, field log books, a field sampling notebook, and chain of custody forms;
- a copy of the Field Operations Plan, including, at a minimum, the Field Sampling Plan, the Health and Safety Plan, and the Quality Assurance Plan; and
- all required personal protective equipment and decontamination equipment as specified in the Field Sampling and Health and Safety Plans.

6.0 Decontamination

The gauze should be prerinsed and allowed to air dry before arrival at the sampling site. The specific solvent to be used and procedures to be followed are dependent upon the analyte of interest; this information will be specified in the QAPJP and FSP. Standard operating procedures ADL-1009 (for decontamination of stainless steel template, tweezers or forceps, and ruler) are to be followed.

7.0 Wipe Sampling Procedure

Upon arrival at each site, the following procedures will be followed:

- suit up in appropriate personal protective equipment as described in the Health and Safety plan;
- visually inspect the surface(s) to select areas of potential contamination for sampling;
- place a decontaminated stainless steel template onto area of surface to be sampled. If the site is not easily marked with the template (i.e., an irregular non-planar surface), write a detailed description, with measurements from easily identifiable objects, of the area sampled;
- with tweezers or forceps, remove sampling gauze (pre-moistened with preservative or hexane, depending on the analyte) from the pre-labelled sample vial;
- wipe the area from left to right in rows from the top to the bottom of the framed sampling area, using uniform pressure;
- wipe the same area in columns from the top to the bottom from the left side to the right side of the framed sampling area, using uniform pressure;
- replace the gauze in the pre-labelled sample vial;
- fill out the appropriate chain of custody forms and prepare the sample for storage and shipping.

8.0 Documentation

Documentation of all wipe sampling activities including the maintenance of a detailed field notebook are described in Standard Operating Procedure ADL-4014.

9.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing Sections 7.0 and 8.0 a minimum of twice under the direct supervision of a senior consultant from the Earth Sciences and Engineering Unit (943) or his/her designee.

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COLLECTION AND HANDLING OF SEDIMENT SAMPLES

Written By:	Approved By/Date:	QA Concurrence/Date:
Tony Parkin	<i>[Signature]</i> 4/8/93	<i>[Signature]</i> 4/8/93 HILTON RIVERA

This SOP Contains 8 Sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 References
- 4.0 Associated SOPs
- 5.0 Equipment
- 6.0 Procedure
- 7.0 Chain of Custody Forms and Sample Labels
- 8.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to provide a set of guidelines to field sampling personnel responsible for the collection and handling of sediment samples.

2.0 Application

This SOP provides step by step guidelines to be followed by field personnel responsible for the collection and handling of sediment samples from rivers, streams and standing bodies of water.

3.0 References

A Compendium of Superfund Field Operations Methods, Office of Emergency and Remedial Response, Office of Waste Programs Enforcement, U.S. Environmental Protection Agency, EPA/540/P-87/001, December 1987.

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Refer to specific Survey Plans or Quality Assurance/Work Plans for the scope of work associated with individual sediment sampling programs.

4.0 Associated SOPs

ADL-1008 USA-1001
ADL-1009
ADL-4014
ADL-1017
ADL-1018

5.0 Equipment

The following equipment is required to perform the collection of sediment samples:

- stainless steel bowl and spoon
- stainless steel dredge
- stainless steel hand auger
- modified Van-Veen grab sampler
- a supply of disposable rope or line;
- chemical resistant gloves;
- water proof boots, hip waders, or chest waders;
- stainless steel knife
- position locationing equipment including, Brunton compass, stainless steel rods, wooden stakes, flagging, location buoys, a weighted measuring tape and a camera;
- decontamination equipment and supplies;

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- coolers and duct tape to ship samples;
- bubble wrap, ziploc bags, and garbage bags to ship samples;
- all required documentation including a sufficient supply of the appropriate field forms, field log books, a field sampling notebook, and chain of custody forms;
- a copy of the Field Operations Plan, including, at a minimum, the Field Sampling Plan, the Health and Safety Plan, and the Quality Assurance Plan; and
- all required personal protective equipment and decontamination equipment as specified in the Field Sampling and Health and Safety Plans.

When collecting samples from a boat or barge, the following support equipment is required in addition to the equipment already listed:

- life jackets for all personnel;
- sufficient lighting and flagging, as needed, for compliance with US Coast Guard requirements;
- spare oars as emergency backup in the event of engine failure;
- radio communications with shoreline personnel; and,
- an anchor.

6.0 Procedure

6.1 Sampling Criteria

Certain criteria are to be met prior to the collection of sediment samples. Locations selected for sediment sampling will be within areas of deposition, i.e., slow moving or standing areas of water. Sediment will be collected to a depth of 12 inches below the sediment-water interface. All loose organic debris will be removed from the sediment surface prior to sampling. Any organic debris which is representative of the depositional environment (i.e., has been buried within the sediment) will remain as

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part of the sample, with the approximate percent of organic material recorded on the sample log. Large stones are to be removed from the samples after the relative percent of the stones has been recorded.

All locations will be approached from a downstream direction to minimize turbidity within the water column; downstream locations will be collected before upstream locations. At locations where surface water samples (see SOP USA-1001) are also scheduled for collection, the corresponding surface water sample will be collected before the sediment sample.

All sampling equipment will be decontaminated prior to use following the procedure outlined in SOP ADL-1009.

All samples intended for volatile organic analyses will be collected as grab samples. All other analytes will be composited in a stainless steel bowl to increase homogeneity. Distribution of the composited sediment sample into the various analyte bottles will not occur until a volume of sediment sufficient to fill all analyte bottles from the location has been collected for composite.

6.2 Collection of Sediment In Shallow Water (0-4 feet)

Collection of samples in areas of shallow water will be conducted by wading to the sampling location. One member of the sampling team will remain in visual contact with the sampler from the shoreline. All sediment samples will be collected using the stainless steel dredge with the following exceptions:

- a stainless steel hand auger may be used for collection of compacted sediments
- a stainless steel spoon may be used for sediment collection beneath a water column of less than six inches

Following collection and distribution, each sample container will be wiped dry and placed on ice in a cooler for the remainder of the days' sampling activities. Following the collection of the sample, the location will be marked by driving a labeled stake into the adjacent bank or shoreline. The position of the sample location will be noted as a range and a bearing to the marked stake. All documentation regarding the sample collection will be made in the field notebook.

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6.3 Collection of Sediment In Deep Water (greater than 4 feet)

Sampling will be conducted from a boat. The boat will be positioned on the sampling location and the water depth at the sample location will be determined using a weighted measuring tape. Sediment samples will be collected using a modified Van Veen grab sampler as outlined in SOP ADL-1019. Sample handling, storage and sample location documentation will be performed as in described section 6.2 and 7.0.

7.0 Chain of Custody Forms and Sample Labels

SOP ADL-1017 and 4014 describe in detail the procedures for filling out sample labels and the Chain of Custody documentation. Sample containers should be prelabeled if possible and the corresponding Chain of Custody Form will be completed before the samples are shipped to the analytical laboratory.

8.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing Sections 6.0 and 7.0 a minimum of twice under the direct supervision of a senior consultant from the Earth Sciences and Engineering Unit (943) or his/her designee.

Collection and Handling of Split Samples

Written By:	Approved By/Date:	QA Concurrence/Date
S. Coons	<i>[Signature]</i> 3/5/93	HILTON RIVERA 3/5/93

This Standard Operating Procedure (SOP) contains eight sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 References
- 4.0 Associated SOPs
- 5.0 Split Sample Collection Procedures
- 6.0 Split Sample Handling Procedures
- 7.0 Health and Safety Protocols
- 8.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to provide field sampling personnel with specific guidelines for the collection and handling of representative split samples for chemical analyses. Special considerations required for specific environmental matrices or specific analytical samples are also addressed.

2.0 Application

This SOP applies to all Arthur D. Little field activities that involve the collection or handling of representative split samples for chemical analyses.

Split samples are generally collected to compare analytical results obtained from different laboratories. Samples may also be split to evaluate the comparability of different analytical laboratory techniques or methods. During oversight of potentially responsible party remedial investigations and feasibility studies, split samples are obtained by the oversight team to check or verify the reported analytical results.

Refer to the specific Field Operations Plan or Quality Assurance/Quality Control Plan for the scope of work associated with the collection of split samples and the number and type of split samples to be collected.

3.0 References

U.S. Environmental Protection Agency. *Guidance on Oversight of Potentially Responsible Party Remedial Investigations and Feasibility Studies*. Washington, DC: Office of Research and Development, July 1991. EPA-540/G-91/010a.

4.0 Associated SOPs

ADL-1010	Surface Soil Sampling
ADL-1011	Ground Water Monitoring Well Sampling
ADL-1013	Surface Water Sampling
ADL-1014	Sediment Sampling
ADL-4014	Geotechnical Documentation
ADL-Y220	Collection and Handling of Field QC Samples
EPA-1000	Sample Containers, Preservatives and Holding Times
EPA-1001	Sample Custody

5.0 Split Sample Collection Procedures

5.1 Sampling Considerations

Split samples are statistically comparable field samples collected at the same place and time by the same sampling crew. For oversight activities split samples are generally collected by the prime sampling contractor, placed into containers provided by the oversight contractor, and relinquished to the oversight contractor for handling. The oversight contractor also has the responsibility to observe and document the sampling procedures followed by the sampling contractor.

In cases where Arthur D. Little is the sample collection contractor as well as the split sampling contractor, Arthur D. Little SOPs must be used. In cases where Arthur D. Little is providing oversight only, the PRP contractors agency-approved SOPs will be the basis for oversight evaluation. The equipment and general documentation requirements appropriate for split samples are identical to those specified for the collection of the specific type of field sample. The Arthur D. Little procedures for collection of representative field samples from different environmental matrices (i.e., ground water, subsurface soils, etc.) are provided in the associated SOPs listed in Section 4.0.

Split samples are collected by dividing a field sample into two or more portions. If a sampling device is employed to obtain the environmental sample, split samples are collected as replicate samples; if the sample containers themselves are used to collect the samples, the split samples are collocate samples, collected one after the other. (Replicate sample are defined as samples that have been obtained by dividing an environmental sample into two or more portions; collocate samples are defined as samples that have been collected as independent samples at the same time and place in such a manner that they are equally representative of the parameters of interest. See SOP ADL-Y220 for further discussion.)

Split samples may be collected for a single analyte, a group of analytes, or for all analytes addressed in the analytical program, as indicated in the project scope of work and field operations plan. The split samples obtained for each of the analyses will be collected as close together in time as possible, i.e., immediately after each other. The specific procedures to be followed which minimize temporal inhomogeneity are described for each sampling matrix below. The volatiles sample and corresponding split sample will be collected first, followed by each remaining analyte with associated splits. Sample containers for all other analyses will be filled with the remaining volume and subsequently collected volumes, as described in Section 5.2.

To assure that representative split samples are obtained, special considerations are necessary for the collection of specific environmental matrices and for specific analytical samples; these special considerations are discussed below.

5.2 Ground Water Split Samples

Ground water split samples can be collected either by pumping directly from a monitoring well or by using a bailer to collect sample aliquots which are then distributed into the appropriate sample containers. The same procedure used to collect the ground water samples for the specific project will be used to collect the split samples.

Pump Samples

- When a properly developed ground water well is sampled using a pump, the ground water sample is generally distributed directly into the sample containers. Appropriate volumes will also be pumped directly into the split sample containers.

- Assuming aquifer stabilization is achieved immediately prior to sampling, the sampled ground water is considered to be homogeneous and the split samples are considered replicates.

Bailer Samples

- If a bailer is used to sample ground water, the split samples will also be collected using the same collection device and the split samples are considered replicates.
- If the capacity of the sample collection device is inadequate to allow all split sample containers for a given analyte, each bailer volume will be equally divided between associated field and split sample containers until both containers are filled. (Note: If the volumes of the split sample containers are different, the containers will be filled proportionately to ensure that each container contains the same proportion of the all subsamples.) This sample volume distribution process will continue on an analyte by analyte basis until all bottles from each sample set are full. Individual split sample containers will not be filled sequentially with successive bailer volumes.

Filtered Samples

If splits of filtered samples are to be collected, (e.g., for filtered metals analyses), the following procedures will be followed.

- When using a pump with an in-line filter, samples will be distributed directly into the sample containers as described above.
- When using a bailer to collect ground water samples, the split sample containers will be filled with unfiltered ground water, as described above. Each sample will then be filtered into a second set of clean sample containers in the following manner: the volume in the first sample container will be filtered and distributed proportionately among the clean split sample containers, then the volume in the next sample container will be filtered and distributed, and so on until all split samples for the specific analyses have been filled.
- Preservatives will be added to the final filtered samples.

5.3 Surface Water Split Samples

Surface water samples can be collected using a variety of methods including the use of a stainless steel bomb sampler or equivalent to collect water samples from discrete depths within the water column, direct submergence of sample containers, or direct pumping from a specific depth. Split samples obtained using a sample collection device are considered replicate samples; split samples collected directly into the sample containers are considered collocate samples.

Discrete Bomb Sampler

- Surface water split samples will be collected using the same sampling equipment employed for the overall surface water sampling program.
- If the capacity of the sample collection device is inadequate to allow all split sample containers of a given analysis type to be filled, an equal portion of the water sample will be placed in each of the split sample containers and the water will be resampled as soon as possible and at the same location until the containers are filled.
- If the volumes of the split sample containers are different, the containers will be filled proportionately to ensure that each container contains the same proportion of the all surface water subsamples.

Sampling Pump

- Samples will be distributed directly from the pump to the sample containers and from the pump to the split sample containers.

Direct Submergence

- The sample containers and the split sample containers will each be directly submerged at the same location and to the same depth.

Sampling Order

- The split samples for any one type of analytical sample will be collected/distributed immediately after the project field sample is collected.
- If split samples for volatiles analyses are to be collected, all volatiles sample containers will be filled first.

- Sample containers for all other analyses will be filled with the remaining volume and subsequently collected volumes, as described in Section 5.1 above.

Filtered Samples

If splits of filtered samples are to be collected, (e.g., for filtered metals analyses), the following procedure will be followed.

- The split sample containers will be filled with unfiltered surface water as described above.
- Each sample will then be filtered into a second set of clean sample containers in the following manner: the volume in the first sample container will be filtered and distributed proportionately among the clean split sample containers, then the volume in the next sample container will be filtered and distributed, and so on until all split samples for the specific analyses have been filled.
- Preservatives will be added to the final filtered samples.

5.4 Soil and Sediment Split Samples

Collection of split samples of soils or sediments presents special problems due to the non-homogeneity of the matrix. To ensure collection of the most representative split sample possible, the following procedures are specified.

- Soil and sediment split samples will be collected using the same sampling equipment and procedures employed for the collection of the programmatic soil and sediment field samples.
- Split samples for the volatiles analyses will be collected as grab samples as opposed to composite samples and are considered collocates.
- Split samples for the other analyses (semivolatiles, metals, etc.) will be collected by extracting a sample volume sufficient to fill all field and split sample containers for all analytes, mixing the total volume until a uniform blend is achieved, and distributing representative portions of the composite into corresponding analyte containers until all bottles are full. These samples are considered replicates.

6.0 Split Sample Handling Procedures

6.1 Containers

Split samples may not always be placed in identical sample containers due to potential differences in requirements of the oversight contractor and the sampling contractor or due to different sources of sample containers. Split samples collected for Arthur D. Little projects will be placed in containers appropriate for the selected analyses, as specified in SOP EPA-1000. Preservatives will be added to the samples after collection, as indicated in SOP EPA-1000.

6.2 Documentation

Documentation of all split sampling activities, including the completion of all sample labels and chain-of-custody forms and the maintenance of a detailed field notebook, is the responsibility of the Arthur D. Little field staff and will be conducted as described in SOP ADL-4014 and EPA-1001.

6.3 Shipment

At the end of each day split samples will be packed in ice and shipped directly from the field in custody-sealed coolers to the appropriate analytical laboratory for the specific project. Shipment of split samples will be handled by Arthur D. Little field staff as specified in SOP EPA-1001.

7.0 Health and Safety Considerations

All health and safety monitoring and personal protective gear for Arthur D. Little split sampling staff will conform to the Arthur D. Little site-specific Health and Safety Plan submitted for the specific project, or, in the case of oversight programs, to the PRP site-specific Health and Safety Plan if reviewed and approved by Arthur D. Little's Health and Safety Officer.

8.0 Measure of Proficiency

Field staff will be under the direct supervision of the designated field coordinator for this project. Recommendations regarding collection of the split samples for oversight purposes will not be made to the sampling crew by the oversight contractor; any deviations from the recommended procedures detailed in Section 5.0 of this SOP will be noted.

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Date: June 16, 1993
Revision No.: 0
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OPERATION OF THE HORIBA OCMA-220 OIL CONTENT ANALYZER

Written By:	Approved By/Date:	QA Concurrence/Date
A. Kronick	<i>[Signature]</i> 6/16/93	HILTON 6/16/93

This SOP contains 10 sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 References
- 4.0 Associated SOPs
- 5.0 Equipment
- 6.0 Calibration Procedure
- 7.0 Measurement Procedures
- 8.0 Documentation
- 9.0 Safety Considerations
- 10.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to provide sampling and geotechnical field personnel with a set of guidelines, to insure proper operation of the Horiba OCMA-220 Oil Content Analyzer.

2.0 Application

This SOP provides a step-by-step guideline to be followed by personnel responsible for performing or overseeing operation of the Horiba OCMA-220 Oil Content Analyzer. This instrument is designed to measure organic hydrocarbon in aqueous and solid matrices. It uses a nondispersive infrared analyzer (NDIR) to measure concentration of hydrocarbons in the solvent solution.

3.0 References

EPA Test Method 418.1, Total Recoverable Petroleum Hydrocarbons, Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March 1983.

4.0 Associated SOPs

ADL-1001	Sample Custody
ADL-1005	Sample and Extract Storage
USA-1000	Sample Containers, Preservatives and Holding Times

5.0 Equipment

The following equipment is necessary for the proper analysis of samples:

- Horiba OCMA-220 Oil Content Analyzer.
- 2 x 20 ml syringes.
- 25 µl micro by ring for calibration.
- 200 ml glass beaker.
- 10 ml heavy oil calibration.
- Water/oil filters.
- 3 ounce wide mouth amber sample jars.
- Sample labels and clear tape.
- Spatulas for sample handling.
- 5 gallon plastic jug to contain waste solvent.
- A copy of the Field Operations Plan, including, at a minimum, the Field Sampling Plan, the Health and Safety Plan, and the Quality Assurance Plan; and
- All required personal protective equipment and decontamination equipment as specified in the Field Sampling and Health and Safety Plans.

6.0 Calibration Procedure

- Allow 60 minutes for warming up after POWER is turned on. Press RANGE to select measuring range (50 ppm) and set EX. TIME to appropriate position. Place a 100 or 200 ml glass beaker with about 10 ml water in it underneath sample discharge pipe.

6.1 Zero Calibration

- 6.1.1 Turn EXTRACTOR to CLOSE (1). Pour 15 ml of tap water and 15 ml of solvent into inlet (2).
- 6.1.2 Press EXTRACT (3). Extraction will stop automatically at the time preset on EX. TIME. Check to see good separation of water and solvent at monitor window (4).
- 6.1.3 Turn DISCHARGE to CLOSE (5) and EXTRACTOR to OPEN (6). Wait one minute. Close EXTRACTOR (1).
- 6.1.4 Open DISCHARGE (8) to drain IR cell only.
- 6.1.5 Repeat A-3 and A-4 for a total of three times. (Do not open discharge, A-4, on the third aliquot.)
- 6.1.6 At third aliquot, press MEASURE (7) and adjust ZERO to read display at zero.
- 6.1.7 Press MEASURE (7) again and turn DISCHARGE to OPEN (8).

This completes the zero calibration.

6.2 Span Calibration Using Check

The span check has been preset at the factory to 40 ppm. It may be readjusted with the span potentiometer to 33 for reading mg per liter.

- 6.2.1 Follow steps A-1 through A-6.
- 6.2.2 Press and hold the CHECK button. Adjust display to read 40 ppm.

6.2.3 Press and hold the CHECK button again; change to 200 ppm range and confirm reading of 160 ppm.

6.2.4 Follow step A-7.

This completes span check.

7.0 Measurement Procedures

7.0.1 Turn EXTRACTOR to CLOSE (1). Pour x ml of sample water and y ml of solvent into inlet (2).

7.0.2 Follow A-2 through A-5.

7.0.3 Press MEASURE (7) and read data on display.

7.0.4 Follow A-7.

7.0.5 Remarks

- For 50 ppm range: x=15, y=15. For 200 ppm range x=5, y=20.
- Always zero analyzer with clean solvent after use to keep the IR cell clean.

7.1 Measure of Sample Soil

EPA Test Method 418.1, Total Recoverable Petroleum Hydrocarbons, utilizes solvent extraction and infrared spectrophotometric analysis. A simple procedure for the analysis of total recoverable petroleum hydrocarbons in soil is as follows:

7.1.1 Calibrate the OCMA-220 in terms of milligrams per liter of standard reference oil, per Sections 6 and 7 of the OCMA-220 instruction manual.

7.1.2 Weigh 10 grams of soil (+/- 0.1 gram).

7.1.3 To a 40 ml volatile organic analysis vial, add the soil and 1 or more grams of anhydrous sodium sulfate to dry the sample. Mix the soil and the Na_2SO_4 well. Add 1 or more grams of silica gel (60-200 mesh Davidson Grade 950 or equivalent). Stir or shake to mix. Add 30 ml of solvent. Stir or shake to mix.

- 7.1.4 Perform the extraction of hydrocarbons into the solvent using the model GE-50 50 Watt Ultrasonic Disruptor. Sonicate for about 1 minute. Put the VOA bottle in a water bath to cool and settle, for approximately 2 minutes.
- 7.1.5 Carefully pour the extract through a solvent rinsed and dried Whatman No. 40, 11 cm, filter paper into the OCMA-220. Confirm that a minimum of 15 ml of extract is available for measurement. Add tap water or a measured amount of solvent, if necessary, to fill the extract chamber to the full line. If solvent is added, mix using the OCMA-220 extractor for several second. Measure three aliquots from the extract. Disregard the first two and read the third as the final concentration.
- 7.1.6 If necessary, drain and dilute the extract to display the results between 0 and 50, note the dilution ratio.
- 7.1.7 Calculate total recoverable petroleum hydrocarbons in milligrams per kilogram using the following formula:

$$TPH = (C \times D \times V) / Kg$$

Where: C = concentration in milligrams per liter from the OCMA-220.
D = dilution ratio = (volume of solvent for extraction + volume of solvent for dilution if needed)/volume of solvent for extraction.
V = volume of extract in liters.
Kg = soil sample mass in kilograms.

Example: $\frac{10.0 \text{ mg/L} \times 1 \times 0.030 \text{ L}}{0.010 \text{ Kg}} = 30 \text{ mg per kilogram}$

8.0 Documentation

All documentation is to be completed in ink on field log forms, in a dedicated field notebook or on laboratory technician log. Consult QAP or Workplans for additional details.

9.0 Safety Considerations

This SOP requires the use of hazardous chemicals. These include: methanol, freon, chlorobenzene, iso-octane, etc. All field personnel will be briefed by the Field Team Leader before the conduct of the first sampling on the hazards and safe handling of these and any other chemicals on site.

Personnel should avoid direct contact with all chemicals and avoid breathing fumes. Contact with solvents will cause irritation of eyes, nose, throat, and skin. Material Safety Data Sheets (MSDS) will be available for each hazardous material in use. MSDS describe chemical properties, health hazards, and protection and safety measures. Refer to MSDS if unsure of the characteristics of a chemical. Follow these general guidelines when handling chemicals:

1. Wear chemical protective gloves (laboratory latex if possible).
2. Wear safety glasses (most sun glasses and corrective glasses are not safety glasses).
3. Work in a well-ventilated area.
4. Store chemicals securely and well padded.

Waste solvents must be collected and disposed of separately from other waste streams. Collect all waste solvents in a compatible container which is clearly labelled as waste solvents. Solvent waste should be stored safely just as the other chemicals until properly disposed of.

Please refer to the project specific Health and Safety Plan for further information.

10.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing Sections 6.0 and 7.0 a minimum of twice under the direct supervision of a senior consultant from the Earth Sciences and Engineering Unit (943) or his/her designee.

SOP No. ADL-4000
Date Initiated: June 1, 1990
Revision No.: 0
Revision Date:
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Exploratory Pit/Trench Procedures

Written By:	Approved By:	Date:	QA Concurrence:	Date:
J.Fortner <i>J.F.</i>	R.Lambe <i>R.L.</i>	6/8/90	J.Harris <i>JCH</i>	6/20/90

This SOP contains ten sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 References
- 4.0 Associated SOPs
- 5.0 Equipment
- 6.0 Site Entry
- 7.0 Subsurface Clearance
- 8.0 Pit/Trench Procedures
- 9.0 Documentation
- 10.0 Measure of Proficiency

1.0 Purpose

Excavating a pit or trench is typically used to obtain data on shallow, subsurface stratigraphy, depth to ground water, exploration of geophysical anomalies, and subsurface sampling and/or monitoring.

2.0 Application

This SOP provides a step-by-step guideline to be followed by the site geologist when conducting site characterizations utilizing exploratory pits and trenches.

3.0 References

Code of Federal Regulations, Title 29-Part 1926, Sub part P: Excavations, Trenching, and Shoring.

4.0 Associated SOPs

ADL-1010	ADL-1015
ADL-4005	ADL-4006
ADL-4007	ADL-4014
ADL-5012	ADL-5016

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5.0 Equipment

5.1 Heavy Equipment Failure

If equipment failure occurs on site, which results in the release of any hazardous material (eg. petroleum products, hydraulic fluids, transmission fluids etc.), the source will be immediately isolated and contained, and precautionary measures (eg. lined with plastic etc.) will be taken to protect the site from contamination.

Records describing the incident will be maintained by Arthur D. Little, Inc. The information recorded will include:

- cause of spill;
- type of spill;
- approximate amount of spill;
- time interval of event;
- precautionary measures taken;
- impact on site; and,
- remediation conducted.

5.2 Required Geotechnical Equipment

The following list of geotechnical equipment is required for the Site Geologist:

- A photo or flame ionization detector;
- a Geologic Society of America Rock-Color Chart (Munsell System);
- a copy of the Unified Soils Classification System;
- a copy of the site Work, QA/QC, and Health and Safety Plans;
- a tape measure and compass so that the excavation can accurately be located with respect to a known reference;
- a 10x (minimum) hand lens;
- a graduated stadia rod or equivalent;
- a sufficient amount of Caution/Hazard tape to define each work zone;

- a camera (with flash); and,
- a field notebook and appropriate geotechnical field forms

6.0 Site Entry

6.1 Inspections and Certifications

All heavy equipment (eg. backhoes, trailers, pumps, compressors, generators etc.) will be inspected by the Site Geologist. This inspection will evaluate the condition of the equipment with respect to potential contamination sources. No equipment which is observed to be leaking or saturated with petroleum products, hydraulic fluid, transmission fluid, or coolant will be utilized on site until the source of the contaminants has been identified and addressed, and the contamination has been removed via steam cleaning (ADL-4007) and approved by Arthur D. Little, Inc. At this time, Arthur D. Little will also inspect the appropriateness and adequacy of the subcontractor personnel protection gear with respect to the site Health and Safety Plan. No work shall begin until approval resulting from each of these inspections is given by Arthur D. Little.

In addition to these inspections, all required certification(s) (eg. OSHA health and safety training, certified hammer weight, state and/or federal licenses and permits etc.) which are required prior to initiation of the work and which has not been previously submitted to Arthur D. Little, Inc., must be presented by the subcontractors upon arrival at the site.

If proper certification is not presented upon arrival at the site, admission to the site will not be granted.

6.2 Orientation Meeting

An orientation meeting will be held on site involving a client representative (if requested by the client), the Arthur D. Little team, and all subcontractors. The following will be accomplished at this meeting:

- introduction of the client and/or site background;
- introduction of the Arthur D. Little team and each members role and responsibilities;
- introduction of the subcontractors and their individual roles and responsibilities;
- explanation of the program objectives;
- provide all personnel with health and safety information, including but not limited to: a list of all potential site contaminants, a list of emergency phone numbers, a map locating an on site medical aid station, a map showing routes

to the nearest emergency medical facility, and a map indicating restriction zones; and,

- discuss any factors unique to the site (eg. specific site entrance and exit procedures etc.).

7.0 Subsurface Clearance

All knowledgeable parties (eg. public utility companies, plant engineers etc.) must approve the pit or trench location to assure risk minimization with respect to encountering unexpected subsurface hazards and obstacles. In cases where information on subsurface conditions is limited, subsurface clearance may require confirmation using geophysical techniques to assure safety.

8.0 Pit and Trench Procedures

8.1 Pit and Trench Excavation

A geologist shall be present and responsible at each operating backhoe to: direct the excavation; maintain field notes; prepare pit or trench logs; monitor the air and soil quality; record any ground water data; log samples; acquire photodocumentation of the excavation; and, maintain chain-of custody logs.

Exploratory pits and trenches shall be prepared in advance as follows:

- Using a Brunton compass and tape measure, the Site Geologist shall locate the center of each pit and/or the end points of each trench with respect to a permanent fixed marker (e.g., property corners). Additionally the orientation of each pit and trench shall also be noted; and,
- each pit center and/or trench end point shall be marked to facilitate the process of subsurface clearance. Final Scheduling of excavations shall proceed upon final verification of subsurface clearance.

Exploratory pits and trenches shall be excavated as follows:

- All personnel necessary for participation in the pit or trench program, as specified in the Work Plan, must be present prior to initiating the excavation;
- calibrate the photo or flame ionization detector in accordance with **ADL-5012** for HNU PI-101 operation and **ADL-5016** for OVA operation
- establish a work zone using Caution/Hazard tape;
- suit-up in specified personal protective gear, as required;
- determine the orientation of the pit or trench and begin excavation;

- deposit excavated soil in a manner which minimizes the potential for a "cave-in";
- regularly monitor the excavated soil for volatile organic compounds. All readings are to be recorded in the field note book and appropriate geotechnical forms along with the approximate depth from which the soil pertaining to specific readings was excavated;
- construction of each pit or trench will comply with OSHA regulations as described in 29 CFR 1926; and,
- identify and log one wall of the pit or trench including a schematic wall diagram, upon completion of the excavation. Additionally, the geologist shall determine the pit or trench dimensions, depth to water, and photodocument the logged wall using a stadia rod or equivalent for scale.

8.2 Pit and Trench Sampling

Unless otherwise specified, all chemical and geotechnical soils samples will be collected as composites from the spoils pile. At no time is anyone to enter the exploratory pit or trench.

Geotechnical soils samples are to be sealed in sample jars by placing a layer of aluminum foil across the top then affixing the screw top so that a headspace analysis can be conducted at a later date (ADL-1015). Geotechnical samples are to be labeled and stored in accordance with ADL-4005 and ADL-4006 respectively. Soils samples collected for chemical analyses shall conform with ADL-1010.

8.3 Pit and Trench Closure

Upon completion of each exploratory pit or trench, all excavated materials will be immediately and completely returned to the excavation, and tamped flush with the ground surface.

9.0 Documentation

Documentation of all pit and trenching activities including all geotechnical forms and the maintenance of a detailed field notebook are described in ADL-4014.

10.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing Sections 8.0 and 9.0 a minimum of twice under the direct supervision of a senior consultant from the Earth Sciences and Engineering Unit (943) or their designee.

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Date Initiated: June 1, 1990
Revision No.: 0
Revision Date:
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Geotechnical Documentation

Written By:	Approved By:	Date:	QA Concurrence:	Date:
J.Fortner <i>(signature)</i>	D.Langseth <i>DL</i>	6/7/90	J.Harris <i>jch</i>	6/20/90

This SOP contains seven sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 Reference
- 4.0 Associated SOPs
- 5.0 Geotechnical Field Books
- 6.0 Geotechnical Field Forms
- 7.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to outline, in detail, the required documentation needed to maintain accurate logs and files of all geotechnical procedures conducted by Arthur D. Little.

2.0 Application

This SOP provides documentation guidelines, including examples, required for all geotechnical exploratory and sampling procedures conducted or overseen by Arthur D. Little personnel (see table 1).

3.0 References

None

4.0 Associated SOPs

ADL-1010	ADL-1011	ADL-4013
ADL-1012	ADL-1013	
ADL-1014	ADL-1015	
ADL-1016	ADL-4000	
ADL-4001	ADL-4002	
ADL-4003	ADL-4004	
ADL-4005	ADL-4006	
ADL-4007	ADL-4008	
ADL-4009	ADL-4010	
ADL-4011	ADL-4012	

5.0 Geotechnical Field Books

All geotechnical field books should be pocket-size "Rite in the Rain" or equivalent and should have non-removable pages. These field books are to be dedicated to a case, and the Case Leader is responsible for maintaining a field book inventory. This inventory should include a numbering and tracking mechanism for each field book assigned to a particular case.

Each field book is to be maintained as follows:

- Label front cover with the following information: Arthur D. Little name and address, case number, case leader, book number, book start date, and book completion date;
- affix a postage guaranteed Arthur D. Little return label to the inside cover of each field book;
- document the name and time interval for each field person assigned custody of the book by the case leader on the first page of the field notebook;
- maintain all field notes directly in the field books (i.e., notes are not to be taken then transferred to the field books at a later time);
- record all field notes in permanent ink;
- initial and date each page upon completion;
- correction of mistakes are made by striking with a single line and initialing the correction, and;
- avoid blank spaces within the notes. Unavoidable blank spaces are to be struck with a single line.

Examples of information required within the field book includes: The date of entry; time of entry for specific events; a meteorologic description including daily changes; personnel present including arrival and departure times and affiliations; make, model and condition of all equipment utilized; the time interval and reasons for delays including a detailed description of corrective actions taken by individuals; and a detailed description and rationale for any deviations for the Work, Sampling, or Health and Safety Plan.

6.0 Geotechnical Field Forms

The geotechnical field forms have been designed to detail all steps, actions, and readings associated with specific field procedures. These forms are to be completed in full. No sections of the forms are to be left blank; if a section is

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"not applicable", it is to be indicated as such. All forms, including location diagrams, are to be completed in the field with permanent ink. Refer to Table 1 to see which forms are required for specific field procedures. Examples of each form are also attached.

7.0 Measure of Proficiency

Proficiency assessment for documentation is associated with specific procedural proficiency , therefore, no separate proficiency measures for documentation are needed.

Table 1: Geotechnical Form Usage With Respect to Field Procedures

Geotechnical Form

* Continuation Pages Available

Field Procedures

	Exploratory Pit/Trench Procedures	Surface Soil Sampling	Exploratory Drilling	Monitoring Well Installation	Ground Water Sampling	Aquifer Pump Testing	Vessel Sampling	Surface Water Sampling
Field Notebook	●	●	●	●	●	●	●	●
Excavation Profile Log	●							
Soil Sample Log*		●						
Daily Drilling Report			●	●				
Soil Boring Log*			●	●				
Monitoring Well Design*				●				
Ground Water Monitoring Report*				●	●	●		
Well Development Report				●				
Monitoring Well Sampling Data Sheet					●			
Pump Test Data Sheet						●		
Tank and Sump Sampling Data Sheet							●	
Chain of Custody Record	●	●	●	●	●		●	●
Surface Water Sampling Data Sheet								●

Arthur D Little	Daily Drilling Report		Boring No.
			Client
			Project
			Case No.
Date	Boring Complete: Yes <input type="checkbox"/> No <input type="checkbox"/>		Well Complete: Yes <input type="checkbox"/> No <input type="checkbox"/>
Contractor		Hole Diameter	
Drill Method		Casing Size	
Type Of Rig		Grout method	
Geologist		Boring Depth	
Development Method			
Start Of Shift, Time		End Of Shift, Time	
Start Of Shift, Depth		End Of Shift, Depth	
Summary Of Daily Events			
Description Of Materials Used			
Length of Riser _____ (ft.)		Other Materials	
Length of Screen _____ (ft.)			
Bentonite Powder _____ (No. of Bags)			
Bentonite Pellets _____ (No. of Buckets)			
Liquid Bentonite _____ (No. of Gallons)			
Portland Cement _____ (No. of Bags)			
Type of Surface Casing _____			
Comments			
Signature _____ Date _____			

Boring No.
Client
Project
Case No.

[illegible]

Arthur D Little**Soil Boring Log**

Boring No.

Client

Project

Case No.

Date Start

Contractor

Date Complete

Drill Method

Hole Diameter

Type Of Rig

Casing Size

Drilling Additives

Boring Depth

Geologist

Sampling Method

LOCATION

Scale in Feet	SAMPLE			Blows Per 6"	Total Organics (ppm)	GEOLOGIC DESCRIPTION Unified Soil Class ID, color (Munsell System), grain size, sorting, moisture, compaction, indication of contaminants (unusual odor or sheen), and general stratigraphic description
	Type and number	Interval	Recovery			

0.0

Arthur D Little**Monitoring Well Design**

Boring No. _____

Client _____

Project _____

Case No. _____

Date Start _____

Date Complete _____

Hole Diameter _____

Casing Size _____

Contractor _____

Geologist _____

Drill Method _____

Boring Depth _____

Type Of Rig _____

Grout method _____

Datum _____

Development Method _____

Notes _____

Scale in Feet	SAMPLE		Well Construction Diagram		Construction Specifications
	Type and number	Total Organics (ppm)	Stratigraphy	Annulus Well	
0.0					Elevation Top Of Casing _____ Elevation Top Of Riser Pipe _____ Elevation Ground Surface _____ (surveyed elevations) _____ (depth from ground surface) _____ Type of Surface Casing _____ I.D. Surface Casing _____ Type Of Riser Pipe _____ I.D. Riser Pipe _____ Diameter Of Borehole _____ Type Of Backfill _____ Type Of Seal _____ Depth To Top Of Seal _____ Type Of Sand Pack _____ Depth To Top Of Sand Pack _____ Type Of Screen _____ Slot Size _____ I.D. Screen _____ Screened Interval _____ Depth To Bottom Of Well _____ Depth To Bottom Of Borehole _____

Arthur D Little

Monitoring Well Design
(Continuation Page)

Boring No.

Client

Project

Case No.

Scale
in
Feet

SAMPLE

Type
and
number

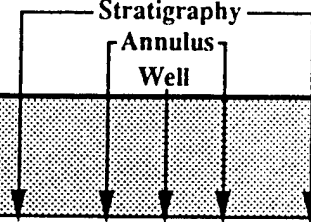
Total
Organics
(ppm)

Well Construction Diagram

Stratigraphy

Annulus
Well

Notes and Comments



Arthur D Little	Well Development Report		Well No. _____																																																																															
			Client _____																																																																															
			Project _____																																																																															
			Case No. _____																																																																															
Installation Date _____		Development Date _____		LOCATION																																																																														
Depth To Screen Bottom _____		Depth To Water Table _____																																																																																
Water Level (Relative To Top Of Well Riser)																																																																																		
Before Development _____ 24 Hours After Development _____																																																																																		
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<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th colspan="5" rowspan="2" style="text-align: left; padding: 5px;">MEASUREMENTS</th> <th colspan="3" style="text-align: center; padding: 5px;">TABLE</th> </tr> <tr> <th style="text-align: center; padding: 5px;">Well</th> <th colspan="2" style="text-align: center; padding: 5px;">Annulus *</th> </tr> <tr> <th style="text-align: left; padding: 5px;">Number of Gallons Removed</th> <th style="text-align: center; padding: 5px;">pH</th> <th style="text-align: center; padding: 5px;">Conductivity</th> <th style="text-align: center; padding: 5px;">Temperature</th> <th style="text-align: center; padding: 5px;">Dissolved Oxygen</th> <th style="text-align: center; padding: 5px;">V well</th> <th style="text-align: center; padding: 5px;">dia</th> <th style="text-align: center; padding: 5px;">V annulus</th> </tr> <tr> <td style="padding: 5px;">0.0 gallons</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td rowspan="4" style="text-align: center; padding: 5px;">2" 0.17gal/ft</td> <td style="text-align: center; padding: 5px;">6.5</td> <td style="text-align: center; padding: 5px;">0.46gal/ft</td> </tr> <tr> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">7.25</td> <td style="text-align: center; padding: 5px;">0.59gal/ft</td> </tr> <tr> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">7.75</td> <td style="text-align: center; padding: 5px;">0.69gal/ft</td> </tr> <tr> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">8.25</td> <td style="text-align: center; padding: 5px;">0.79gal/ft</td> </tr> <tr> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td rowspan="3" style="text-align: center; padding: 5px;">4" 0.66gal/ft</td> <td style="text-align: center; padding: 5px;">8.25</td> <td style="text-align: center; padding: 5px;">0.64gal/ft</td> </tr> <tr> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">10.25</td> <td style="text-align: center; padding: 5px;">1.06gal/ft</td> </tr> <tr> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">12.25</td> <td style="text-align: center; padding: 5px;">1.63gal/ft</td> </tr> <tr> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">_____</td> <td style="text-align: center; padding: 5px;">6" 1.5gal/ft</td> <td style="text-align: center; padding: 5px;">12.25</td> <td style="text-align: center; padding: 5px;">1.41gal/ft</td> </tr> </table>					MEASUREMENTS					TABLE			Well	Annulus *		Number of Gallons Removed	pH	Conductivity	Temperature	Dissolved Oxygen	V well	dia	V annulus	0.0 gallons	_____	_____	_____	_____	2" 0.17gal/ft	6.5	0.46gal/ft	_____	_____	_____	_____	_____	7.25	0.59gal/ft	_____	_____	_____	_____	_____	7.75	0.69gal/ft	_____	_____	_____	_____	_____	8.25	0.79gal/ft	_____	_____	_____	_____	_____	4" 0.66gal/ft	8.25	0.64gal/ft	_____	_____	_____	_____	_____	10.25	1.06gal/ft	_____	_____	_____	_____	_____	12.25	1.63gal/ft	_____	_____	_____	_____	_____	6" 1.5gal/ft	12.25	1.41gal/ft
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Depth to Sediment: Before _____ After _____																																																																																		
Type/Capacity of pump _____																																																																																		
Pumping Rate _____			Recharge Time _____																																																																															
Time to Develop Well: Start _____ Finish _____ Duration _____																																																																																		
COMMENTS (include description of water removed)																																																																																		
* Assumes 30% porosity for sand pack																																																																																		

Arthur D Little	Monitoring Well Sampling Data Sheet				Well No.				
					Client				
					Project				
					Case No.				
Vacuation Method			Date		LOCATION				
Sampling Method			Equipment Used (Calibrated Y/N)						
Sampling Personnel			Initial Well PID (ppm)						
WELL VOLUME (* use appropriate values in table for each code letter)									
<div style="display: flex; justify-content: space-between; align-items: flex-start;"> <div style="text-align: center;"> V well <input style="width: 100px;" type="text"/> </div> <div style="text-align: center;"> Depth Screen Bottom <input style="width: 100px;" type="text"/> </div> <div style="text-align: center;"> Depth Water <input style="width: 100px;" type="text"/> </div> <div style="text-align: center;"> Gallons of Water (well) <input style="width: 100px;" type="text"/> </div> </div> $\left[\left(\text{Depth Screen Bottom} - \text{Depth Water} \right) \times \text{V well} \right] = \text{Gallons of Water (well)}$									
ANNULAR VOLUME (ASSUME 30% POROSITY)									
<div style="display: flex; justify-content: space-between; align-items: flex-start;"> <div style="text-align: center;"> V annulus <input style="width: 100px;" type="text"/> </div> <div style="text-align: center;"> Depth Screen Bottom <input style="width: 100px;" type="text"/> </div> <div style="text-align: center;"> Depth Bottom of Seal <input style="width: 100px;" type="text"/> </div> <div style="text-align: center;"> Gallons of Water (annulus) <input style="width: 100px;" type="text"/> </div> </div> $\left[\left(\text{Depth Screen Bottom} - \text{Depth Bottom of Seal} \right) \times \text{V annulus} \right] = \text{Gallons of Water (annulus)}$									
WATER TO BE REMOVED									
<div style="display: flex; justify-content: space-between; align-items: flex-start;"> <div style="text-align: center;"> Gallons of Water (well) <input style="width: 100px;" type="text"/> </div> <div style="text-align: center;"> Gallons of Water (annulus) <input style="width: 100px;" type="text"/> </div> <div style="text-align: center;"> Removal Multiplier <input style="width: 100px;" type="text"/> </div> <div style="text-align: center;"> Total Gallons to be Removed <input style="width: 100px;" type="text"/> </div> <div style="text-align: center;"> Actual Gallons Removed <input style="width: 100px;" type="text"/> </div> </div> $\left[\left(\text{Gallons of Water (well)} + \text{Gallons of Water (annulus)} \right) \times \text{Removal Multiplier} \right] = \text{Total Gallons to be Removed}$									
MEASUREMENTS						Well		Annulus *	
						V well	dia	V annulus	
<div style="display: flex; justify-content: space-between;"> <div style="width: 15%;"> Well Purging Volume Removed <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> </div> <div style="width: 15%;"> pH <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> </div> <div style="width: 15%;"> Conduct. <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> </div> <div style="width: 15%;"> Temp. <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> </div> <div style="width: 15%;"> Free CL⁻ Y/N <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> </div> <div style="width: 15%;"> Dissolved Oxygen <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> </div> </div>						2"	6.5	0.46gal/ft	
						0.17gal/ft	7.25	0.59gal/ft	
							7.75	0.69gal/ft	
							8.25	0.79gal/ft	
						4"	8.25	0.64gal/ft	
						0.66gal/ft	10.25	1.06gal/ft	
							12.25	1.63gal/ft	
						6"	12.25	1.41gal/ft	
						1.5gal/ft			
						Post Sampling <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p> <p><input style="width: 100px;" type="text"/></p>			
SAMPLING									
Decontamination Procedures Used <input type="checkbox"/> Detergent Wash, Water Rinse, Solvent Rinse, Water Rinse <input type="checkbox"/> Detergent Wash Water Rinse <input type="checkbox"/> Other									
Sample ID	Analysis	Volume (ml)	Filtered (Y/N)	Preservation	Container	Time			
<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>			
<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>			
<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>			
<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>			
<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>			
<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>			
<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>			
<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input style="width: 100px;" type="text"/>			
Notes (include data on floaters/sinkers with measuring device, well condition, etc.)									

Signature _____ Date _____ No. of Bottles _____

Arthur D Little

Arthur D Little	Surface Water Sampling Data Sheet	Date _____
		Client _____
		Project _____
		Case No. _____

LOCATION

Sampling Location Description _____

Type Of Water Body _____

Channel Width _____ Channel Depth _____ Est. Flow _____

Discharge Points (Y/N) Location _____

Odors, Surface Sheen _____

LOCATION DIAGRAM (Indicate orientation, sampling locations, discharge/recharge points, etc.)

SAMPLING PROCEDURE

Equipment Used (Calibrated Y/N) _____

Solvent Used _____

Decontamination Procedures Used

☐ Detergent Wash
 Water Rinse
 Solvent Rinse
 Water Rinse

☐ Solvent Rinse
 Water Rinse

☐ Detergent Wash
 Water Rinse

☐ Other

PRE SAMPLING

TEMP	pH	COND	D.O.	FREE CL ⁻ Y/N	OTHER	TIME
_____	_____	_____	_____	_____	_____	_____

SAMPLING

SAMPLE	METHOD	VOLUME (ml)	FILTERED (Y/N)	PRESERV.	OTHER	TIME
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____

POST SAMPLING

TEMP	pH	COND	D.O.	FREE CL ⁻ Y/N	OTHER	TIME
_____	_____	_____	_____	_____	_____	_____

NOTES

Signature _____ Date _____ No. Of Bottles _____

Arthur D Little**Pump Test
Data Sheet**

Well No. _____

Client _____

Project _____

Case No. _____

Start Test

Date _____
Time _____ (am/pm)

Equipment _____

LOCATION

End Test

Date _____
Time _____ (am/pm)

Tester(s) _____

Pumping Well ID. # _____

Drawdown
or
Recovery
(D or R)Current
TimeElapsed
Time
(t)Depth
to
WaterPumping
Rate
(Q)

Remarks

Entered
By**Arthur D Little**

Arthur D Little**Tank and Sump Sampling
Data Sheet**

Date _____

Client _____

Project _____

Case No. _____

TANK / SUMP DESCRIPTION

Sampling Access Description _____

Leak Detection / Monitoring Present (Describe) _____

Tank / Sump Dimensions (LxWxH) _____ Total Volume _____ % Full _____

Tank / Sump Status: Active _____ Inactive _____ Date Installed _____ Age _____

Type Of Construction _____

Content History _____

HEALTH and SAFETY MONITORING

Equipment Used (Calibrated Y/N) _____

Air Quality Readings	Pre-Sampling	Time	Reading	Time	Reading
	During Sampling	_____	_____	_____	_____
	During Sampling	_____	_____	_____	_____
	During Sampling	_____	_____	_____	_____
	Post-Sampling	_____	_____	_____	_____

SAMPLING PROCEDURE

Equipment Used (Calibrated Y/N) _____

Decontamination Procedures Used

☐Detergent Wash
Water Rinse
Solvent Rinse
Water Rinse☐Solvent Rinse
Water Rinse☐Detergent Wash
Water Rinse☐

Other

Solvent Used _____

SAMPLING

SAMPLE	METHOD	VOLUME (ml)	FILTERED (Y/N)	PRESERV.	OTHER	TIME
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____

LOCATION DIAGRAM and NOTES (Indicate orientation, sampling locations, discharge / fill points)

Signature _____ Date _____ No. Of Bottles _____

Page ____ of ____

Arthur D Little		Soil Sample Log		Client
				Project
				Case No.
				Date
Sampling Method			Equipment Used	
Geologist(s)			Decontamination Procedure	
Comments				
Location Diagram (Give distances to ensure reproducibility)				
Sample Number	Auger Hole ID	Total Organics (ppm)	GEOLOGIC DESCRIPTION Unified Soil Class ID, color (Munsell System), grain size, sorting, moisture, compaction, indication of contaminants (unusual odor or sheen), and general stratigraphic description	

Arthur D Little

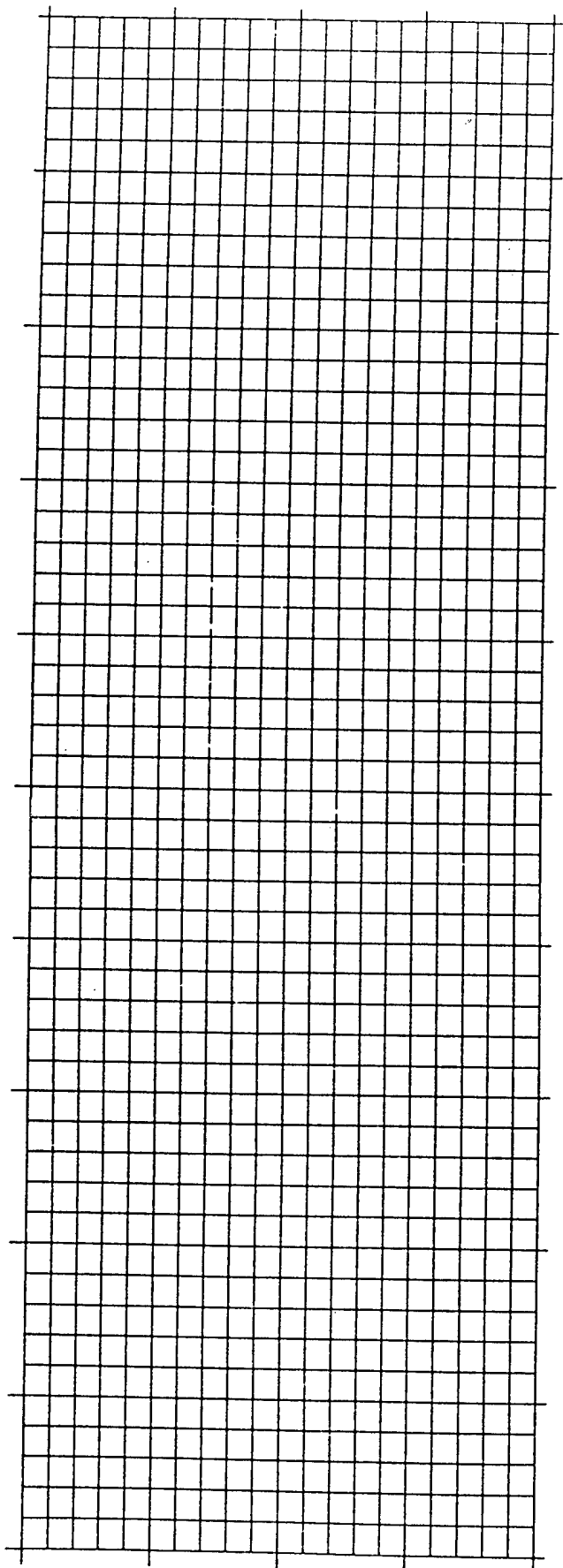
EXCAVATION PROFILE LOG

Client
Project
Case No.
Date

LOCATION

Date Start
Date Complete
Sampling Method
Pit/Trench Dimensions (LxWxD)
Pit Orientation (include wall depicted)

Contractor
Heavy Equipment ID
Geologist
Vapor Monitoring Device



Scale (1 inch = ___ feet)


Directions: Locate on profile (in code) all stratigraphic layers, sample locations, and other areas of comment. This profile should be as close to scale as possible. Identify all codes used below.

Was pit/Trench Photographed (Y/N) Type and Number of Samples Collected

CHAIN OF CUSTODY RECORD

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

**IN-SITU PERMEABILITY TESTING (SLUG TESTING) WITH HYDRAULIC
CONDUCTIVITY DATA REDUCTION**

Written By:	Approved By/Date:	QA Concurrence/Date
L. Kahn	 10-15-92	HILTON RIVERA 11-10-92

This SOP contains 10 Sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 References
- 4.0 Associated SOPs
- 5.0 Equipment
- 6.0 Decontamination
- 7.0 Slug Test Procedures
- 8.0 Slug Test Data Reduction Procedures
- 9.0 Documentation
- 10.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to provide geotechnical field personnel responsible for the in-situ permeability testing of monitoring wells, herein referred to as slug testing, with a set of guidelines to assure proper monitoring well permeability testing, and to provide a set of guidelines for the proper reduction of the raw test data into accurate localized hydraulic conductivity values.

2.0 Application

This SOP provides a step-by-step guideline to be followed by geotechnical field personnel responsible for performing or overseeing monitoring well slug test procedures, and a step-by-step guideline for personnel performing the reduction of the slug test data.

3.0 References

- See Hermit Data Logger Product Literature

- See Hermit Data Logger Data Transfer Software Literature
- See Pressure Transducer Literature
- "The Bouwer and Rice Slug Test - An Update", Groundwater, Vol. 27, No. 3, June 1989, pgs. 304-309
- "Measurement of Parameters: Piezometer Tests (Hvorslev)", Groundwater Resource Evaluation, Chap. 8, pgs. 339-342

4.0 Associated SOPs

ADL-1008	ADL-1009
ADL-4010	ADL-4012
ADL-4014	ADL-5012
ADL-5028	

5.0 Equipment

The following equipment is necessary to properly perform a monitoring well slug test:

- a well key or well access equipment;
- a photo or flame ionization detector to monitor and record volatile organic compounds present in the well headspace;
- an electric water meter or oil/water interface probe (if free floating product is suspected) calibrated to a hundredth of a foot, and sufficiently long enough to reach the total depth of the well;
- Hermit data logger and all accessory and power cables;
- field printer, printer paper, and ink ribbon;
- 10, 20, 30, 40, or 50 psi pressure transducer, dependent upon the amount of water column in the proposed wells (each psi transducer has a maximum depth of submersion -- refer to pressure transducer literature for details of the limits for each psi transducer);
- all equipment manuals (refer to product literature references above);

- various sized solid PVC surge blocks (slugs) of known volume, including at least one-foot and three-foot block with outside diameters small enough to fit generously within the proposed monitor wells;
- a sufficient amount of strong disposable nylon cord equal to at least the well depth of each well to be tested;
- duct tape;
- a knife;
- a timing device such as a watch or clock;
- decontamination equipment outlined in SOPs **ADL-1008** and **ADL-1009**;
- personal protective equipment as specified in the project Health and Safety Plan; and
- a field notebook.

The following equipment is necessary to perform the slug test data reduction:

- a PC computer equipped with the Hermit data logger data transfer software (Lotus) and the Arthur D. Little proprietary hydraulic conductivity data reduction software (Quatro-pro).

6.0 Decontamination

All equipment which will come in contact with the monitoring well and/or ground water will be decontaminated prior to arrival on site, relocation on site, and site exit. Standard Operating Procedures **ADL-1008** (for Teflon, Delrin, and glass) and **ADL-1009** (for metal) shall be followed.

7.0 Slug Test Procedures

7.1 Pre-test Procedures

Upon arrival at each well, the following procedures will be followed:

- suit up in appropriate personal protective equipment as described in the site

Health and Safety Plan;

- unlock and open well cap;
- monitor the headspace within the well using the photo or flame ionization detector (SOP **ADL-5012** for HNu PI-101 operation and **ADL-5028** for OVA operation). This is done by placing the instrument probe at the opening of the well, and recording the reading in the field book;
- measure and record the depth to water and depth to well bottom using a decontaminated water level meter. If free phase product exists within the well, an interface probe may be required to obtain accurate product and water levels. All measurements are to be made in accordance with SOP **ADL-4012**. Measurements are to be made to the nearest one hundredth of a foot and recorded in the field notebook;
- calculate the feet of water in the well by subtracting the water level measurement from the total well depth. Record the calculation in the field notebook;
- set the pressure transducer probe either 0.5 to 1.0 foot above the well bottom or no deeper than the water depth specified in the pressure transducer literature for the particular psi transducer in use;
- secure the probe by looping and taping the transducer cable to the adjacent standpipe or roadbox, insuring that the portion of the cable inside the well is snug against the side of the PVC riser;
- wait a sufficient amount of time for the water displaced by the submerged equipment to reach equilibrium with the water table;
- "wake" the data logger by pressing any key on its panel (a decimal point should appear on the display after indicating the amount of free working memory);
- set the data logger data parameters as follows: press "enter" and "data" simultaneously; select test number 0 through 9 (as there is available memory for a maximum of ten tests, the test number entered will erase all those above it if prompted to do so); select "log" rate; select "1" input; select "level - EN:Toc" type. Refer to the data logger literature for details of data parameter selection;
- set transducer parameters as follows: press "enter" and "XD" simultaneously; select "000.00" reference (set with the transducer in well, for each newly selected test); enter the scale (see transducer label or probe for value); enter the offset (see transducer label or probe for value). Refer to the data logger literature for details

of transducer parameter selection;

NOTE: test number and reference must be reset with each new test. Pay close attention to the test number that is being entered, as the test number will erase all tests above it if prompted to do so.

7.2 Falling Head Test Procedures

- Chose an appropriate surge block, or slug, in accordance with the feet of water column and inside diameter of the well. Be sure to select a slug which will maximize hydraulic displacement at the given location, while insuring that the slug will not disturb the transducer probe at the bottom of the well nor the transducer cable itself (the probe is highly sensitive);
- attach one well length of disposable nylon cord to the slug and mark the line for approximately one foot above water and for complete slug immersion;
- lower the slug to the first mark and simultaneously press "enter" and "start" on the data logger, in preparation of beginning the test;
- as one field personnel lowers the slug quickly into the water to the second mark on the slug-line, a second field personnel must simultaneously press "enter" on the data logger to begin the test;

NOTE: be sure not to drop the slug into the water, as this action will cause unwanted splashing onto the sides of the well. In addition, attempt to start the data logger immediately prior to complete slug immersion to insure the recording of all necessary data points by the data logger;

- secure the slug-line and wait 10 minutes, as the data logger completes the first three cycles of its four cycle logarithmic data collection process;
- after 10 minutes, press "XD" to see if equilibrium of the water table has been reached, as indicated by a "0.00" reading. If not, continue waiting;
- after equilibrium has been reached or a sufficient amount of time has passed, stop the test by simultaneously pressing "stop" and "enter" and then "stop".

7.3 Rising Head Test Procedures

- Change the test number and re-zero the transducer reference;
- simultaneously press "enter" and "start";

- simultaneously pull the slug out of the water quickly without yanking it, and press "enter" to begin the test;

NOTE: only pull the slug back out of the well to the first mark and secure it, insuring that the slug does not get caught on the transducer cable and disturb the test;

- again, wait for equilibrium or a sufficient amount of time, and then stop the test by simultaneously pressing "enter" and "stop" and then "stop".

7.4 Post-test Procedures

- Carefully disconnect the data logger from the transducer cable and connect it to the field printer via the RS232 port;
- set the RS232 port parameters to match the printer as follows: select a unit number identifying the well location; select the "port" option, selecting the appropriate baud rate for the model data logger and field printer in use. Refer to the data logger literature for RS232 port details;
- print the appropriate falling and rising head tests, obtaining a hard copy of the raw data;

NOTE: be sure to print the tests out before disassembling anything, in case the tests are faulty and have to be re-done. In addition, be sure to print the tests in order from last to first, to insure that accidental erasing of previous data does not occur;

- review the data for quality and determine whether the data is sufficient or if the well needs to be retested. If the quality of the data is questionable, due to insufficient displacement of the water column or movement of the transducer, repeat the previous falling head and rising head test procedures;
- transfer the raw data from the data logger onto a PC computer equipped with the data transfer software. This can be conducted after the completion of the ten test maximum, five falling head and five rising head tests, in order to save down time. Select the "port" option on the data logger and select the appropriate baud rate for the model data logger and PC computer in use. Refer to the data logger literature for port details;
- when transferring the data, chose a file name that indicates the location, whether the test was a falling or rising head, and the number test for that location. For example, the file name for the first falling head and rising head tests conducted at monitoring well 05A would be MW05AFA and MW05ARA respectively.

Likewise, second falling head and rising head tests at this location would be MW05AFB and MW05ARB respectively;

NOTE: be sure to confirm that the data transfer was complete before erasing the raw data in the data logger.

8.0 Slug Test Data Reduction Procedures

Through the use of the Arthur D. Little proprietary hydraulic computer program, logarithmic recovery curves can be developed from the slug test data which are used to calculate the localized hydraulic conductivity values. In order to compensate for the complexities of stratigraphic formations, two methods of calculation (Bouwer & Rice and Hvorslev) are used to provide a representative evaluation of the data. The hydraulic conductivity values are calculated using both methods, taking into consideration the limitations of each method. For instance, although both methods accurately assess data collected from wells in confined and unconfined conditions, stratigraphic changes within the screened interval, and finite borehole storage factors, Bouwer & Rice is particularly good at considering the implications of water levels which reside in the screened interval while Hvorslev is particularly good at considering anisotropy.

8.1 Bouwer & Rice Data Reduction Procedures

In general, the Bouwer & Rice method is conducted as follows (refer to Bouwer & Rice for details):

- import the individual test data to the Bouwer & Rice spreadsheet and enter the appropriate test parameters (Figure 1), including the screen length plus sand pack (L_s), well radius (r_c), well radius plus gravel pack (r_w), saturated thickness (H), well depth from the water table (L_w), and gravel pack porosity (n);
- input to the spreadsheet whether or not the water level intercepted the screened interval. If the water level did intercept the screened interval, (r_c) will be automatically adjusted;
- the equation L_s/r_w will then be automatically calculated, computing the ratio between the saturated screen length plus sand pack and the well radius plus gravel pack;
- according to Bouwer & Rice, there are three dimensionless parameters, A, B, and C, which vary according to well and aquifer geometry. Equations exist for their solution, and they have been plotted graphically (Figure 2). This same graph can

be used for all well and aquifer geometries. Using the value of L_e/r_w as previously mentioned, chose the A, B, and C parameters from the graph and enter them into the spreadsheet. These three parameters are then automatically entered into an equation that renders the natural log of R_e/r_w , where R_e is the radial distance over which the difference between the water level inside the well and the water outside the well is dissipated;

- according to the Bouwer & Rice theory, a semilog plot of drawdown versus time will yield data points through which two straight lines with different slopes can be drawn (Figure 3). The line representing an early time and a large drawdown is representative of the recharge of the sand pack around a well. The second line, corresponding to a later time and a lesser drawdown, is representative of recharge from the natural formation. Draw the lines onto the semilog plot;
- from the second line drawn on the semilog plot of the slug test data, pick two drawdowns (y_o) and (y) and the change in time between them (t). These values are the representative slope of the natural log of R_e/r_w , as previously mentioned, and when entered into the spreadsheet will automatically solve for the hydraulic conductivity value (K). The equation is as follows:

$$K = ((r_c^2 \ln(R_e/r_w))/2L_e)(1/t)(\ln(y_o/yt)).$$

8.2 Hvorslev Data Reduction Procedures

In general, the Hvorslev method is conducted as follows (refer to Hvorslev paper for details):

- import the individual test data to the Hvorslev spreadsheet and enter the appropriate test parameters (Figure 1), including the screen length plus gravel pack (L), well radius (r), and well radius plus gravel pack (R);
- the equation L/R is then automatically calculated, computing the ratio between the screen length plus sand pack and the well radius plus gravel pack. If L/R is greater than 8, then the test data can indeed be evaluated by the Hvorslev method and the natural log of L/R is automatically computed;
- chose from the slug test data the point at which the maximum displacement of water (H_o) occurs. This point of maximum displacement is considered the start of the test, therefore adjust the start time on the spreadsheet accordingly;
- according to the Hvorslev method, a semilog graph of the adjusted time (t) versus the water column divided by the maximum displacement (h/H_o) should yield a

straight-line plot. It is interpreted, however, that the semilog plot will often yield data points through which two straight lines with different slopes can be drawn, similar to the Bouwer & Rice theory (Figure 4). The line representing an early time and a large drawdown is representative of recharge of the sand pack and the line representing a later time and a lesser drawdown is representative of recharge from the natural formation. Draw the two lines on the semilog plot. All data points not associated with the recharge of the natural formation are considered negligible, thus once again adjust the start time on the spreadsheet and choose a new point of maximum displacement. The semilog graph plotted after these adjustments should now yield the straight-line plot as theorized (Figure 5);

- chose from this plot the time (T_o) that would be required for the water level to rise or fall to 37 percent of initial rate of inflow. This time is automatically entered into an equation along with the natural log of L/R , as previously mentioned, solving for the hydraulic conductivity value (K). The equation is as follows:

$$K = (r^2 \ln(L/R)) / (2LT_o).$$

NOTE: for QA purposes, every tenth recovery curve should be plotted by hand.

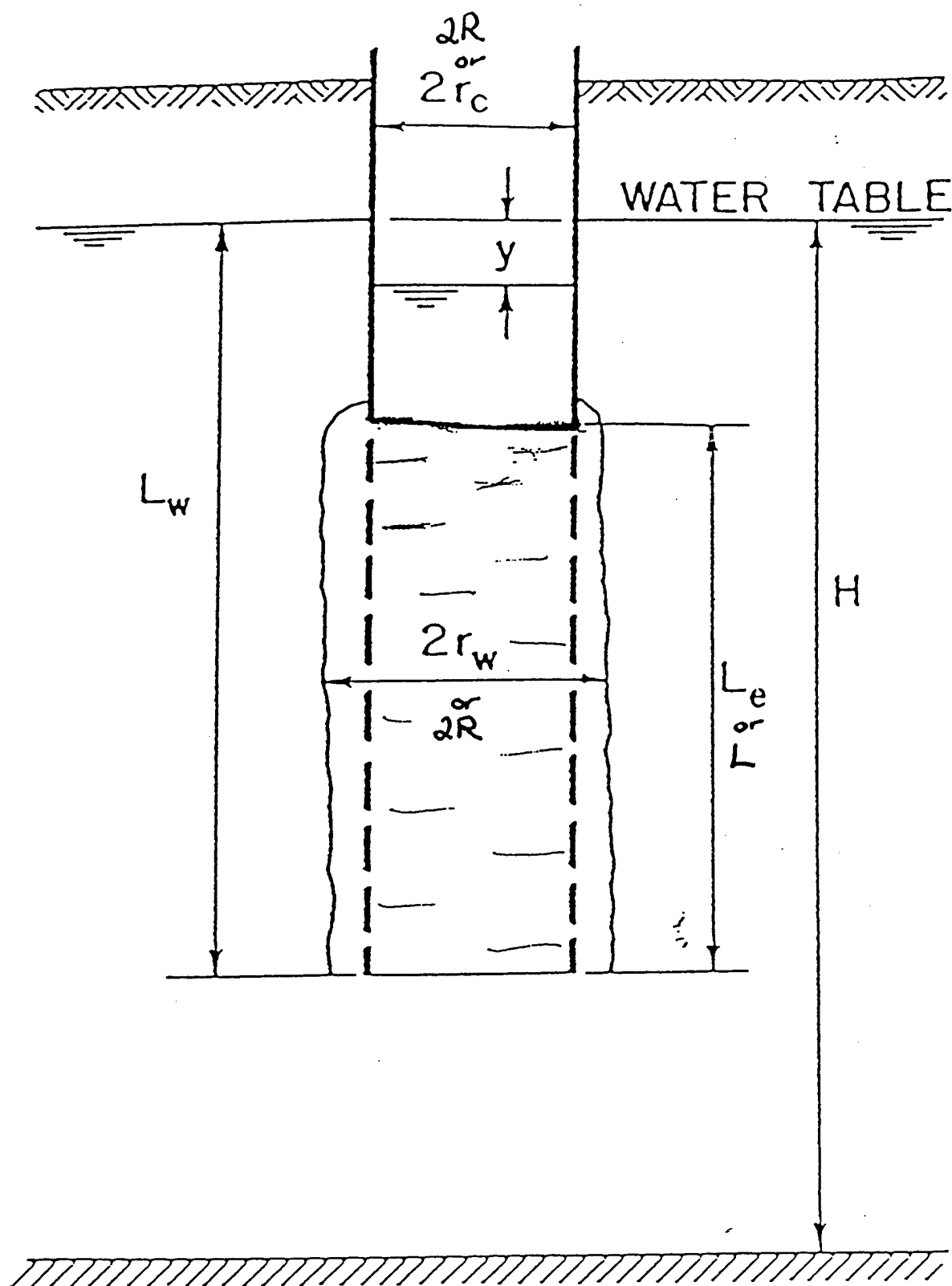
9.0 Documentation

Documentation of all slug test activities and the maintenance of a detailed field notebook are described in SOP ADL-4014. Hard copies of raw data obtained in the field and all hand picked coordinates and lines interpreted for each test during the data reduction procedures must be documented together with hard copies of all data reduction spreadsheets for each test. Additionally, all raw data and data reduction files should be maintained on disk.

10.0 Measure of Proficiency

Field staff will demonstrate proficiency of this SOP by successfully completing sections 6.0, 7.0, 8.0, and 9.0 a minimum of twice under the direct supervision of a senior consultant from the Remedial Planning Unit (943) or their designee.

FIGURE 1. Test Parameters for Bouwer & Rice and Hvorslev



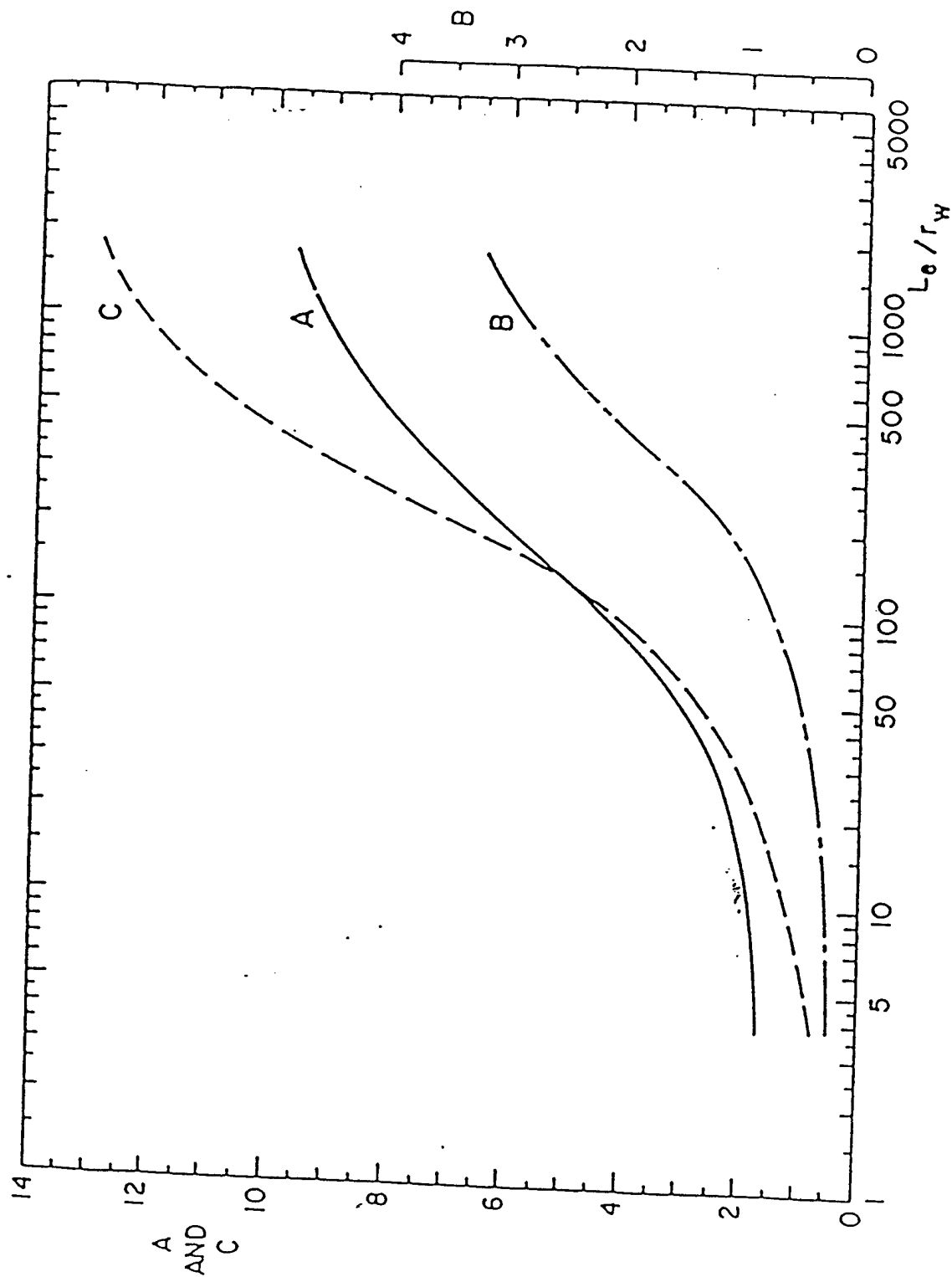


FIGURE 2. Three Dimensionless Parameters A, B, and C, For Use With Bouwer & Rice

FIGURE 3. Bouwer & Rice Semilog Plot of Drawdown Versus Time

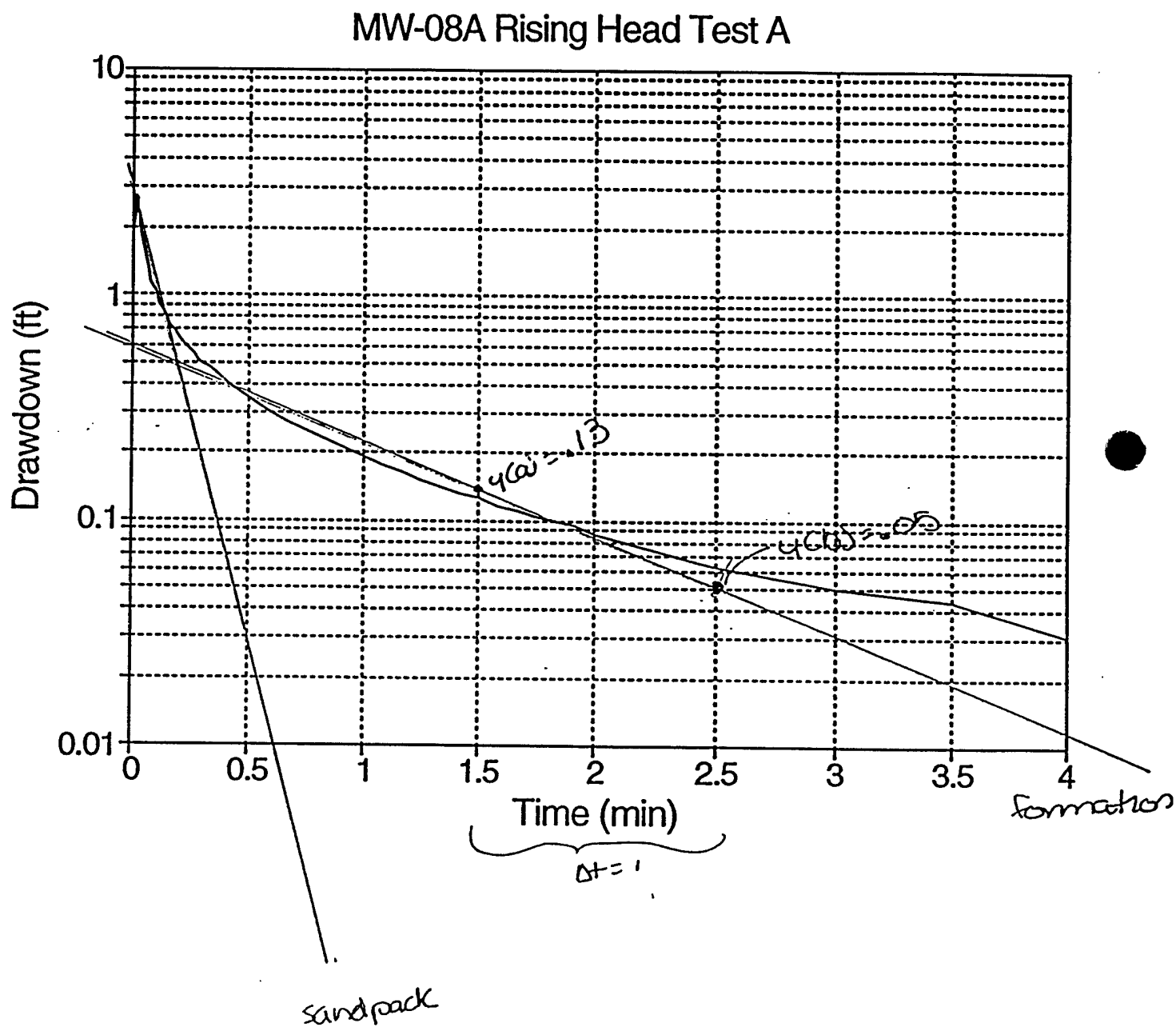


FIGURE 4. Hvorslev Semilog Plot of Adjusted Time Versus Water Column Divided by the Maximum Displacement

H_0 = after rise

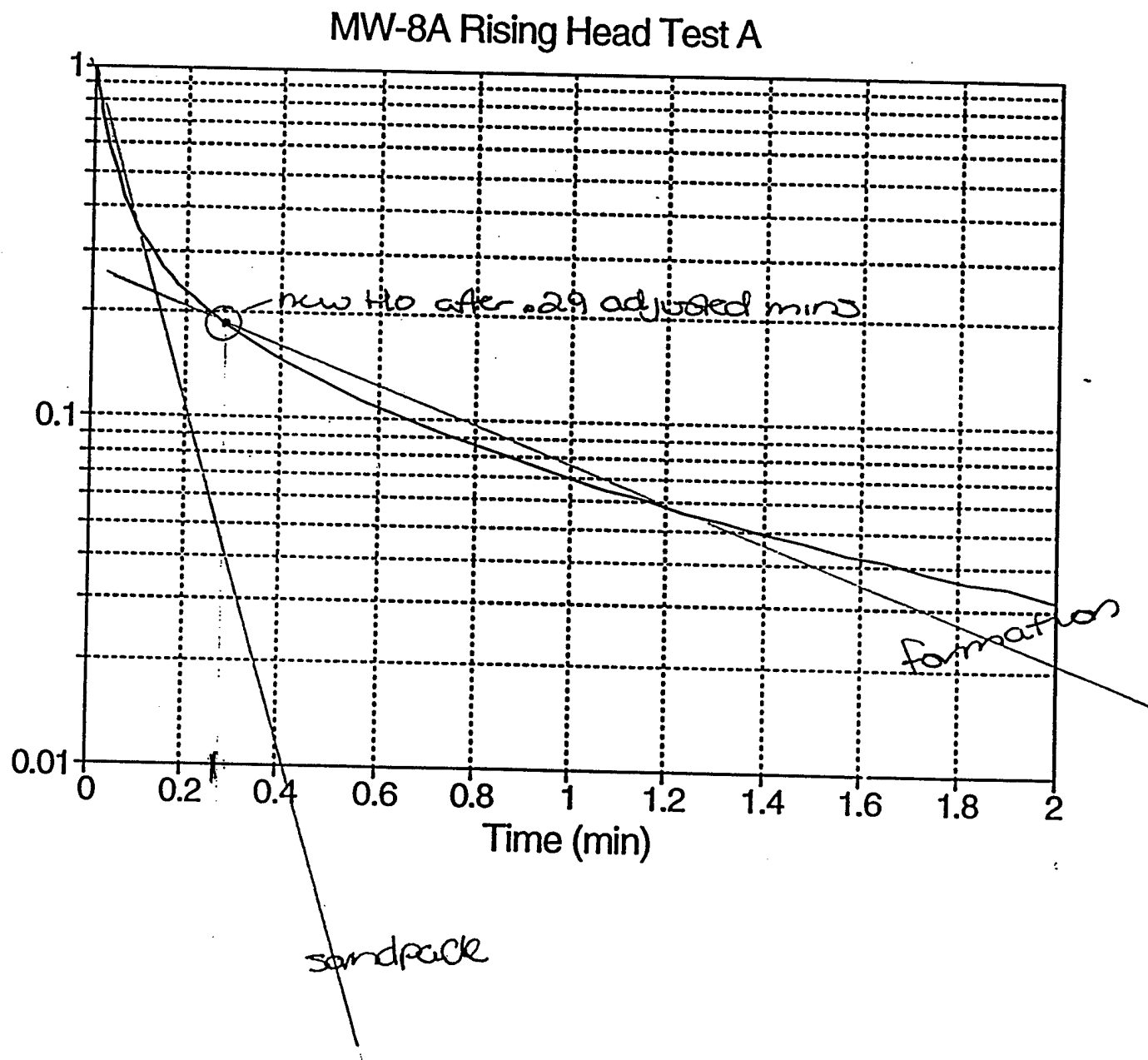
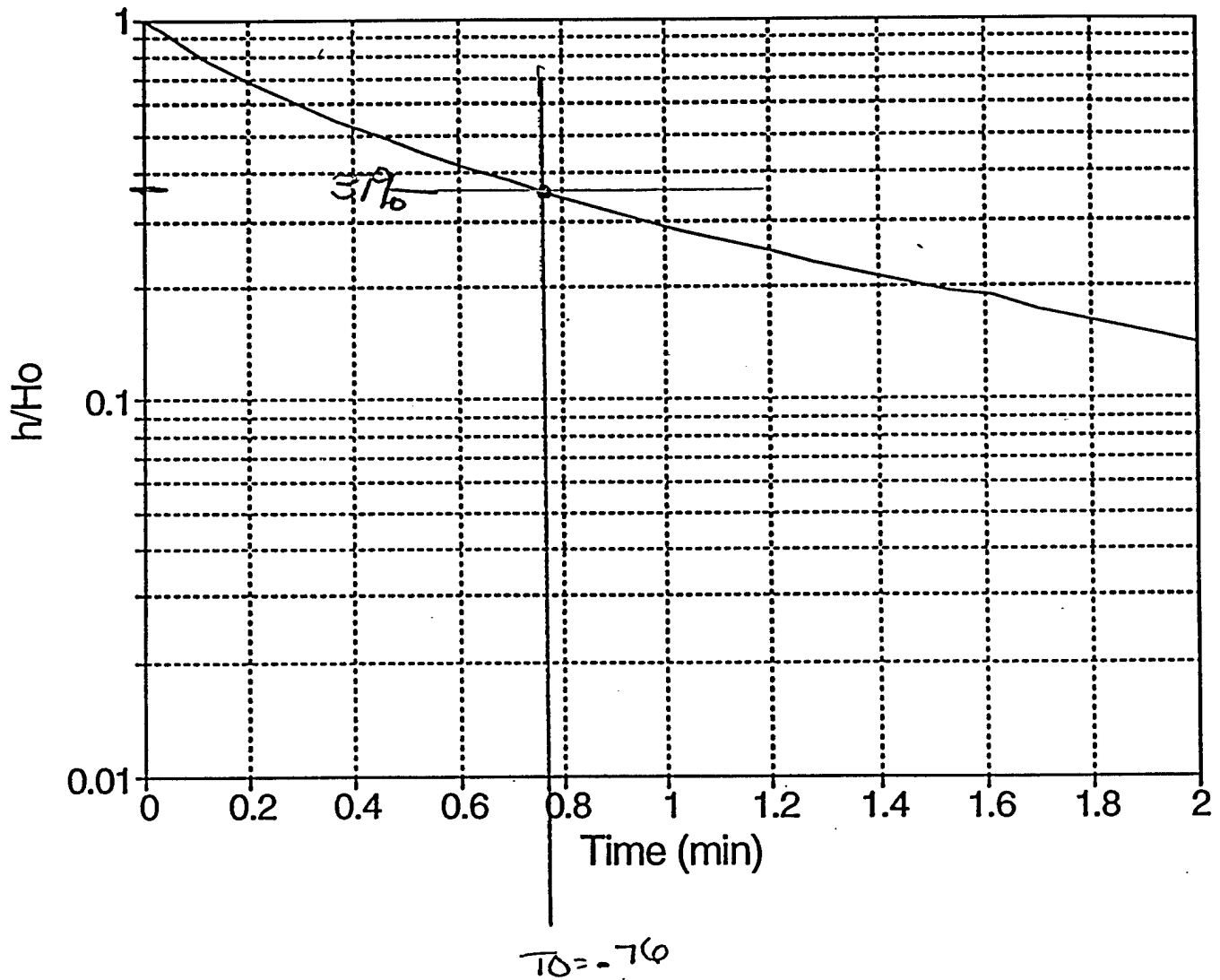


FIGURE 5. Hvorslev Semilog Plot of Re-adjusted Time Versus Water Column Divided by the Adjusted Maximum Displacement

H_0 = after sand pack

MW-8A Rising Head Test A



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CONDUCTIVITY METER CALIBRATION AND MEASUREMENT

Written By:	Approved By/Date:	QA Concurrence/Date
A. Kronick	<i>James E Rice</i> 4/30/93	<i>H. L. TUN, 251522</i> 4/30/93

This SOP contains 5 Sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 References
- 4.0 Associated SOPs
- 5.0 Procedure

1.0 Purpose

The purpose of this SOP is to describe the procedures for performing initial and/or periodic calibrations and measurements using a conductivity Meter

2.0 Application

This procedure applies to all conductivity measurements in the field using a conductivity meter.

3.0 References

Instruction Manual, Type 70 Conductivity Meter, Chemtrix, Inc.

Instruction Manual, Horiba U1000 Multi Meter.

4.0 Associated SOPs

ADL-5013 pH Meter Operation

5.0 Procedure

5.1 Calibration

- 5.1.1 Perform initial and/or periodic calibration by electrical spanning using a decade resistance bridge. Adjust the range as necessary, following procedures given in the instruction manual of the conductivity meter.
- 5.1.2 Perform daily calibrations by dipping a clean cell into each of two solutions of known normality, observing the readings, and adjusting the spans if necessary. Using a conductivity meter with automatic temperature correction to 20 °C, the following readings should be observed:

0.001 N KCL	160 mmhos
0.029 N KCL	4000 mmhos
0.100 N KCL	12,800 mmhos.

5.2 Measurement

- 5.2.1 Calibrate the instrument at the start and end of each day and record the calibration in the field log notebook. For the end of the day calibration, also record in the log, the readings obtained prior to adjustments for each solution.
- 5.2.2 Calibrate more frequently than twice per day if significant drift is observed between the start and end of day readings.
- 5.2.3 Measure the conductivity of an unknown solution by dipping the cell into the solution, gently agitating the cell to remove all gas bubbles, and observing an on-scale reading. Change the range scale as necessary to keep the reading on-scale. Do not allow the probe to touch the sides or bottom of the solution container.
- 5.2.4 Turn off the meter when the probe is not in use.

pH METER OPERATION

A. Calibration

Calibrate the pH meter and probe at the start and end of each day according to the following steps. If the instrument response is found to drift significantly over the course of the day, calibrate more frequently than twice daily.

1. Place clean, preconditioned probe in pH 7.0 buffer and turn FUNCTION control to "pH ATC."
2. Gently stir the buffer solution with the probe. When reading is steady, turn STANDARDIZE control until needle is at 7.0.
3. Rinse probe in distilled or deionized water. Wipe off excess water using a tissue.
4. Place probe in pH 10.0 buffer and gently stir the solution using the probe. When the reading is steady, turn the TEMPERATURE control until the meter reads 10.0.
5. Repeat step 3.
6. Place probe in pH 4.0 buffer and gently stir the solution using the probe. When the reading is steady, the meter should read 4.0.
7. If the meter does not read 4.0 ± 0.1 , use the TEMPERATURE control to correct for half the deviation from pH 4.0 and the STANDARDIZE control to correct for the other half. Repeat step 3.

Recheck the pH readings for the 4.0, 7.0, and 10.0 buffers, repeating step 3 after each measurement. If each reading is not within 0.1 pH unit of the nominal value for that buffer, repeat the calibration.

8. Turn FUNCTION switch to "OFF."

B. Sample pH Measurement

1. Rinse probe with distilled water.
2. Check calibration by repeating steps 1-3 and either 4 or 6 of the standardization procedure above.
3. Place the probe in the sample, stirring gently with the probe. Wait for a steady reading and record the observed value in the notebook.
4. Turn FUNCTION switch to "OFF." Rinse the probe with distilled or deionized water.

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Inspection and Use of the MSA 261 Combustible Gas/Oxygen Meter

Written By:	Approved By:	Date	QA Concurrence	Date
<i>Cory Briggs</i>	<i>David Langstaff</i>	8/9/90	<i>J. Olson</i>	8/10/90

1.0 Purpose

To prescribe routine inspection, use and preventative maintenance for the Mine Safety Appliances (MSA) Portable Indicator/Alarm for Oxygen and Combustible Gas, Model 261.

2.0 Application

The MSA Portable Indicator/Alarm for Oxygen and Combustible Gas, Model 261, is a dual-purpose instrument designed to monitor areas for combustible gases and/or oxygen deficiency. Typically, areas include tanks, manholes, vaults, pits, excavations, chambers, sewers and other confined spaces. In addition, the unit can be used during initial site characterization of hazardous material/waste sites and during field activities to ensure that adequate oxygen is present to perform work and combustible/flammable gases are not in excess of designated limits. Although primarily a portable instrument which is used to spot-check areas, its audible/visible alarm permits the Model 261 to be used as a semi-continuous monitor in work areas where the need for such is indicated.

Reliable measurements of potentially hazardous atmospheres encountered by field personnel demand optimum performance from operations test instruments. This instrument is sensitive and can get out of calibration easily. In consequence, conscientious attention to proper accomplishment of necessary inspections and scheduled maintenance is mandatory. Periodic inspections and maintenance checks are prescribed in this SOP.

3.0 References

MSA Instruction Manual, Portable Indicator and Alarm for Oxygen and Combustible Gas, Model 261
MSA Data Sheet (08-01-08), Portable Indicator and Alarm for Oxygen and Combustible Gas, Model 261 (attached)
Standard Operating Safety Guidelines, USEPA
Air Surveillance for Hazardous Materials, USEPA training manual

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Arthur D. Little ARCS Health and Safety Program Plan, Table 7-2
Arthur D. Little Hazardous Waste Site Training Manual

4.0 Associated SOPs

None applicable.

5.0 Procedure

5.1 Discussion

The MSA Portable Indicator and Alarm for Oxygen and Combustible Gas, Model 261, consists of two distinct detection units housed in an aluminum case, 7" high by 10" wide by 3 3/4" deep. The combustible gas detection portion of the instrument has a range of 0-100% of the lower explosive limit (LEL); the oxygen portion, a range of 0-25%. Both are calibrated at the factory; the combustible gas indicator on pentane, the oxygen indicator on fresh air.

Each indicator has its own alarm light but they share a common alarm horn. The gas indicator is set to alarm at 10% of the LEL; the oxygen indicator when the oxygen level drops to 19.5% or increases above 23%.

The combustible gas "zero adjustment" knob and oxygen calibration knob are mounted on the instrument face panel. Both knobs are clutch-type to avoid unintentional change of settings. The alarm reset button and a push button for checking battery condition are also on the face panel.

The Model 261 is powered by an integral, rechargeable, sealed lead-acid 4.0-volt battery pack which provides 8 to 10 hours of sampling in a fully-charged condition. Normal recharging is accomplished by plugging the charger into a 60 HZ outlet.

5.2 Principle of Operation

The battery-powered pump draws the sampled atmosphere into the instrument, where it diffuses into the sensing heads of the combustible gas and oxygen portions of the instrument.

5.3 Combustible Gas/Oxygen Indicator Components

The following is a list of components/parts which make up the indicator unit:

- the Model 261 primary unit
- 5 or 10 foot synthetic rubber sampling line complete with couplings
- 3-foot plastic or brass probe tube
- cotton pre-filter
- external filter cartridge holder

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- line trap assembly
- MSA Calibration Check Kit, Model R
- spare battery

5.4 Pre-Use Operational Inspection

Each instrument shall be inspected prior to use in order to verify normal operation. The unit must always be checked and zeroed in an uncontaminated atmosphere.

5.4.1 Check battery voltage. Open the instrument lid and turn the center on/off control to the "On" position.

Discontinue the alarms by pressing the "Alarm Reset" button. Both meter pointers will move and one or both alarm light may light.

Press the battery check button located at the lower left hand corner of the face plate. Observe that the needle moves into the acceptable "battery check" zone on the %LEL scale (e.g., greater than 80% of LEL). If the needle is below the low voltage line do not use the unit. Either replace the battery with a fully charged one or recharge the unit.

5.4.2 Verify pump operation. With the instrument turned on, verify pump operation by seeing if the floating "flow ball" indicator located at the lower right corner of the faceplate is moving. Then briefly place your finger over the air sample inlet located on the left side of the unit. The pump should slow down and stop. Do not keep your finger on for any extended time period. If the pump does not slow appreciably, there is leakage at the pump valves or elsewhere in the system, and reliable gas indication may be impossible.

5.4.3 Inspect the sampling system

5.4.3.1 Probe. Inspect the plastic/brass probe for general cleanliness and remove all liquid and solid residue.

5.4.3.2 Filter holder/filter. Inspect the filter holder and the cotton filter for general cleanliness. Replace the cotton filter if soiled.

5.4.3.3 Sampling hoses. Inspect the sampling hoses for damage to rubber surfaces, fittings, linings and "o"-rings. Clean, replace or repair if necessary.

5.4.3.4 Line trap. Inspect the line trap for general cleanliness and damage to surfaces, fittings, linings and "o"-rings. Clean, replace or repair if necessary.

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5.4.3.5 Leak test. Assemble the sample system and attach to the instrument. With the instrument turned on, momentarily hold your finger over the hose inlet. The pump should stop or slow noticeably if there is no leak. If the pump does not slow down or stop, re-check all fittings and leak-check the system again.

5.4.3.6 Check oxygen alarm system. With the instrument turned on the % oxygen meter needle should stabilize at 20.8%. If the needle does not point to 20.8% adjust the level by lifting up on the "Calibrate O₂" knob and turning it accordingly. Check to see that the alarm operates and the light comes on when the needle goes below 19.5%.

5.4.3.7 Check combustibles alarm system. With the instrument turned on the %LEL needle should stabilize at 0%. If the needle does not point to 0% adjust the level by lifting up on the "Zero LEL" knob and turning it accordingly. Check to see that the alarm operates and the light comes on when the needle goes above 10% of the LEL.

5.4.3.8 Alarm reset. The alarm can be reset by pressing the alarm reset button located at the top left of the face plate. Hold the button until the needle is moved below the alarm triggering level.

5.5 Calibration and Maintenance

At least on a monthly basis, calibrate the MSA 261 Combustible Gas/Oxygen meter with a known concentration of pentane gas using the MSA Model R Calibration Check Kit, per the manufacturer's instructions. The kit consists of a flow controlling regulator which includes a gauge to measure container pressure; an adapter hose with sampling line connection; instructions and a case fitted with foam for two cylinders of calibration gas. Calibration gas is 0.75% pentane and 15.0% oxygen in nitrogen.

As needed, thoroughly clean external surfaces of the instrument with a damp (water) cloth and mild soap. Attach an inspection report tag to the unit indicating the date of inspection and the inspector's name.

Repairs of the MSA 261 should be performed by a suitably qualified technician or by the manufacturer.

5.6 Use of the Combustible Gas/Oxygen Meter

Always don appropriate protective equipment (e.g. protective clothing and respiratory protection) prior to conducting tests.

Though it has been designed and tested to be used in hazardous environments, the MSA 261 must be turned on and off in a non-contaminated environment which does not contain a hazardous atmosphere.

Never recharge the unit in a hazardous environment.

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Perform the necessary pre-use checks and /or calibration prior to conducting any atmospheric sampling.

Always allow the unit to "warm-up" and reach ambient temperature before taking readings. The operating temperature range for taking oxygen measurements is 32°F-104°F or 0°F - 104°F if the unit is calibrated at the temperature of use. The operating temperature range for obtaining combustible gas levels is 0°F to 104°F. The operating humidity range is 10%-90% relative humidity (RH).

The response time (to 90% of full scale) for oxygen is 20 seconds at 32°F - 104°F; 3 minutes at 0°F - 32°F. The response time for combustible gas is 15 seconds at 32°F - 104°F.

Though the line trap will assist in preventing liquids from entering the unit, care should always be taken when sampling over liquids. Do not draw liquids into the instrument.

When sampling, make sure that you survey a sufficient number of areas to fully characterize the representative work zone. Since conditions change, a test is good for one time, one place, and one situation. Repeat testing as often as necessary to ensure an appropriate safety factor. Make sure to document test results (e.g., time, location, level detected) in the site-specific log book and/or on an applicable form (e.g., confined space entry permit).

Areas which are traditionally monitored include any combination of the following:

- the breathing zone
- general work area (e.g. ambient)
- areas close to the ground (i.e. flammable/combustibles are typically heavier than air).
- at all possible accessible areas within a tank, vessel, excavation, sumps, ditches, pits or other types of confined space. It may be necessary to don supplied air respirators to thoroughly characterize a work area prior to allowing entry by less protected personnel.
- at all levels (high and low) prior to entering a room, vault or other applicable area.

Be patient when collecting the sample since it takes some time for the air to move up the sample probe and hose to reach the sensors.

Whenever possible, purge the meter with fresh air prior to taking another sample. This is especially true when an unacceptable level of oxygen or combustible gas has triggered an alarm.

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5.7 Interpretation of Results

The Model 261 allows for both oxygen and combustible gases to be monitored simultaneously. If either level is exceeded, an alarm sounds and the respective warning light(s) flashes.

If the level of oxygen goes below 19.5% or above 23% during an initial screening or during periodic sampling of an operation immediately stop work and leave the area. Arthur D. Little policy forbids work in oxygen deficient or oxygen rich atmospheres. Contact the project manager, a supervisor, or a representative of the ADL Occupational Health and Safety Unit for guidance in further evaluating and correcting the situation.

If the level of combustible/flammable gases ranges from 10%-25% of the LEL during an initial screening or during periodic sampling of an operation continue onsite monitoring with extreme caution as higher levels may be expected. If 25% of the LEL is exceeded, immediately stop work and leave the area. Contact the project manager, a supervisor, or a representative from the ADL Occupational Health and Safety Unit for guidance in further evaluating and correcting the situation.

If both levels are exceeded, immediately stop work, leave the area and contact the project manager, a supervisor, or a representative from the ADL Occupational Health and Safety Unit for guidance in further evaluating and correcting the situation.

5.8 Special Precautions

In addition to normal daily instrument inspection and monthly calibration checks, the following precautionary maintenance checks may be necessary for special operations:

Heated Samples. Sampling spaces such hot tanks that are warmer than the instrument may result in condensation of water vapor as the sample passes through the cool sample line. This cooling effect can provide a false reading from a flammability standpoint. Condensation can also block the flow system, corrode the flame arrestor and cause pump valve sticking. Instruments that have been used for such sampling should be inspected for evidence of water vapor condensation.

Filament Poisoning. Sampling spaces that have contained leaded products such as leaded gasoline, silicone, silane or silicate vapors may result in desensitization of the catalytic surface of the platinum filament which seriously impairs the response of the instrument. Acid mists or other corrosive atmospheres will also poison the probe. Concentrations of CO₂ greater than 1% will reduce sensor life. Strong oxidants such as flourine, chlorine, and ozone will lead to erroneously high oxygen readings when these substances are present in concentrations exceeding 5,000 ppm or 0.5%. Changes in barometric pressure due to altitude will also have an effect on the oxygen meter reading. The instrument is calibrated for 20.8% oxygen at sea level. At higher altitudes, the meter will therefore indicate a lower percentage of oxygen by volume. However, adequate oxygen to sustain life is dependent on the partial pressure rather than

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percentage by volume, and a lower reading at a higher altitude is acceptable. Anticipate this situation by consulting topographical maps of sites prior to inspection and making the necessary compensation for the oxygen indicator.

Explosive Dusts/Mists. The instrument will not indicate the presence of explosive or combustible mists or sprays such as lubrication oil or explosive dusts such as grain or coal dusts. In addition, the unit is not capable of measuring the percentage of vapors in steam or inert atmospheres because of a lack of oxygen in the filament chamber which is necessary to support combustion.

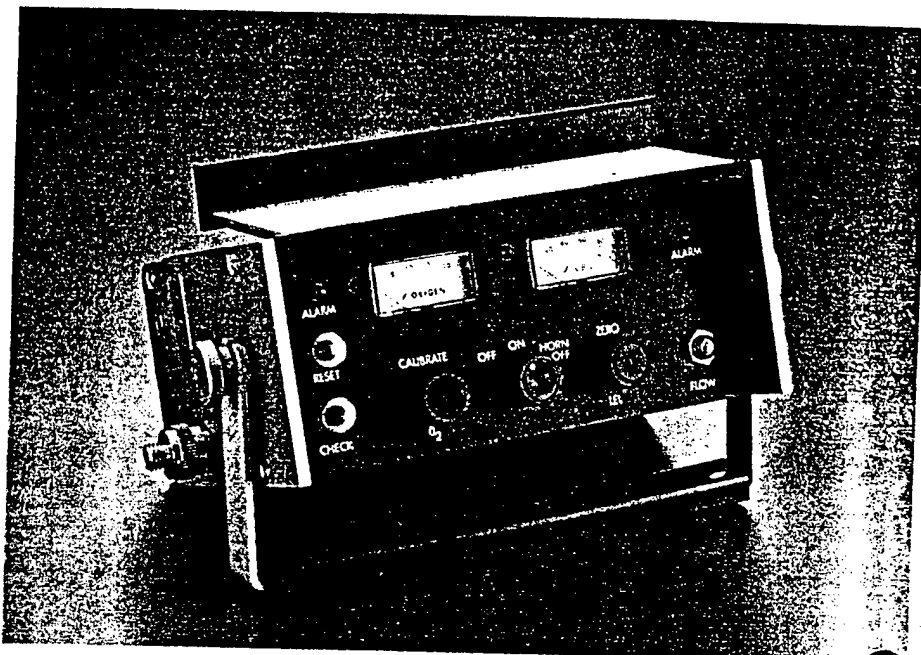
Oxygen Enriched/Deficient Atmospheres. The instrument is not designed to work in an oxygen enriched environment (O_2 greater than 25%) nor will it properly function in an oxygen-deficient atmosphere (below 10.0%).

Instruments that have been used for the sampling noted above should be calibrated more frequently using a known concentration of pentane gas to ensure reliability or measurements.

7.0 Proficiency Measure

Personnel must have completed suitable training in order to be qualified to operate this instrument. Training such as the ADL Hazardous Waste Site Health and Safety course or a special course provided by the Occupational Health and Safety Unit will provide sufficient classroom and hands-on laboratory orientation to meet the proficiency requirements for the inspection and use of this piece of equipment. The user must read this SOP and the unit operating instruction manual prior to use.

Portable Indicator and Alarm Model 261

 (combustible gas
 and oxygen)


Application

The MSA® Portable Indicator/Alarm for Oxygen and Combustible Gas, Model 261, is a dual-purpose instrument designed to monitor areas for combustible gases, and/or oxygen deficiency. Typically, such areas include gas and electric utility properties, vaults, chambers, garages, sewers, and industries where combustible fluids are used. Although primarily a portable instrument, its audible/visible alarm permits the Model 261 to be used as a semi-continuous monitor in work areas where the need for such is indicated. In such cases, a full battery charge gives 8 to 10 hours of continuous monitoring. A built-in pump draws sample from the immediate area or from confined spaces when used with MSA sampling lines.

Description

Features

- Monitors oxygen deficiency and combustible gas with just one instrument
- Both sensors monitor continuously
- Simple operation
- Easy calibration
- Rugged aluminum case, yet compact and lightweight
- Can be carried anywhere to take measurements
- Has large analog meters with easy-to-read scales
- Visible and audible alarm signal when concentration exceeds preset limit
- Horn-off switch setting for alarm acknowledgement
- Latch-in function for over-range in combustible circuit
- Pump allows remote sampling, prior to confined space entry
- Integral filter (washable) protects pump to prolong life
- Low-battery audible alarm and visual indications
- Advanced-design remote charger switches automatically from regular charge rate to trickle rate to prevent overcharge and prolong battery life
- Chargers for either 120 or 240 Vac available

The MSA Portable Indicator and Alarm, Model 261, consists of two distinct detection units housed in an aluminum case, 7" high by 10" wide by 3½" deep. The combustible gas detection portion of the instrument has a range of 0-100% of the Lower Explosive Limit (LEL); the oxygen portion, a range of 0-25%. Both are calibrated at the factory—the combustible gas indicator on pentane, the oxygen indicator on fresh air.

Each indicator has its own alarm light, but they share a common alarm horn. The gas indicator alarms at 25% LEL; the oxygen indicator when oxygen level drops to 19.5% or increases above 23%. Alarm points are preset at the factory but may be field adjusted to other values.

The combustible gas "zero" adjustment knob and oxygen calibration knob are mounted on the instrument face panel. Both knobs are clutch-type to avoid unintentional change of settings. The alarm reset button and a push button for checking battery condition are also on the face panel.

The Model 261 is powered by an integral, rechargeable, sealed lead-acid 4.0-volt battery pack which provides 8 to 10 hours of sampling in a fully-charged condition. Normal recharging is accomplished by plugging the charger into a 60 Hz outlet. Chargers are available for either 120 volts or 240 volts. A push button on the face panel gives an instant check of battery condition. (An external charger adapter is available to charge an additional battery pack.)

The Model 261 is equipped with a carrying handle which can be locked in any position through a 260° arc to provide a base when the instrument is used for semi-continuous sampling. A shoulder/waist harness is available as an optional accessory.

Principle of operation

The battery-powered pump draws the sampled atmosphere into the instrument, where it diffuses into the sensing heads of the combustible gas and oxygen portions of the instrument.

Combustible Gas Indicator

The combustible gas portion of the Model 261 depends upon heat developed by catalytic combustion of the flammable part of the sampled atmosphere on an activated pelletized filament, or Pelement™ unit. This unit forms part of a balanced electrical bridge circuit, which becomes unbalanced as a result of the heat of combustion.

A sample of the monitored atmosphere is passed continuously over the Pelement unit in the sensing head by means of diffusion and a natural draft created by heat from the pelletized filaments. If a flammable mixture is drawn into the chamber, a sintered stainless steel flashback arrestor prevents flame from passing out of the filament chamber and being propagated to the surrounding atmosphere.

When a mixture of flammable gas or vapor in air contacts the active Pelement detector, a rapid combining of the combustible gas with the oxygen in the sample takes place on the Pelement unit surface. This burning of the combustible gas or vapor increases the temperature of the Pelement unit, causing a proportional change in its electrical resistance.

Because a Wheatstone Bridge is considered the most practical device for precise measurement of change in electrical resistance, it is used to continuously measure the Pelement detector's resistance. The change in the resistance creates an imbalance in the electrical circuit, causing a proportional deflection of the meter pointer on the scale. This deflection indicates the concentration of combustible gases or vapors in the sample. The scale is graduated in percent of the Lower Explosive Limit (LEL). Thus a deflection of the meter pointer between 0 and 100% shows how closely the atmosphere being monitored approaches the minimum concentration required for a flammable mixture.

An inactive Pelement is incorporated in the sensing head and is also a part of the electrical bridge circuit. Being exposed to the sample, it helps to maintain circuit balance under changing conditions of flow, temperature and humidity.

Caution: The combustible gas portion of the Model 261 Indicator/Alarm has been designed to detect combustible gases and vapors in air. It is not capable of measuring the percentage of vapors in steam or inert atmospheres because of a lack of oxygen which is necessary to support combustion in the filament chamber. Neither will the instrument indicate the presence of explosive or combustible mists or sprays formed, as for example, from lubrication oils, or explosive dusts produced by grain or coal. The Model 261 is designed for use in air and is not to be used for the measurement of combustibles in atmospheres containing more than 25% or less than 10% oxygen by volume.

Limitations

Silanes, silicones, silicates, and other compounds containing silicon in the tested atmosphere may seriously impair response of this instrument. Some of these materials rapidly "poison" the detector filament so that it will not function properly. When there is even a suspicion that such materials are in the atmosphere being tested, the instrument must be checked frequently (at least after each five tests). A calibration kit is available to conduct this test. Leaded gasoline vapors can also poison the detector filament of this instrument and an inhibitor filament should be used to nullify their effect. Oxygen-deficient (less than 10%) atmospheres may not indicate the true concentrations of combustible gas.

Oxygen Indicator

Oxygen in the Model 261 is sensed directly by a galvanic cell containing two dissimilar electrodes in a basic electrolyte. The entire cell is encapsulated in inert plastic. The sensor face is a fluorocarbon polymer.

Oxygen diffusing through the cell face initiates redox reactions which generate a minute current proportional to the oxygen partial pressure.

The signal is amplified through a battery-powered circuit. A temperature-compensated circuit converts the current to a proportional voltage which is displayed on the meter of the indicator as oxygen concentration in the range of 0-25%.

Temperature compensation error: Maximum +5 percent of full scale in the range 32°F to 104°F (0°C to 40°C) when calibrated at 68°F (20°C.)

Pressure: The sensing cell responds to the partial pressure of oxygen in the atmosphere being tested; atmospheric pressure changes will, therefore, be indicated as changes in percent concentration.

Caution: The O₂ sensor is enclosed in a special sealed package. It must be removed from this package and installed into the flow system before the Model 261 can be used.

Using the Model 261

Before attempting a measurement, the combustible gas meter should be "zeroed" and the oxygen meter calibrated to 20.8% in fresh air. All circuits, including the alarms, are activated when the OFF, ON, HORN OFF switch is moved to the ON position.

When the needle of either meter reaches its preset alarm point, the horn sounds and the appropriate Red Alarm Light turns on. The horn can be silenced by moving the OFF, ON, HORN OFF switch to the HORN OFF position, at which time the pilot light will flash. It will continue to flash as long as the instrument is operating and the knob remains in the HORN OFF position. When the combustible concentration drops below its alarm set point, or the oxygen goes above or below its respective low or high set point, the horn silences automatically but the visual alarms remain lighted until the circuit is reset manually.

Specifications

Performance

Accuracy:

Oxygen: $\pm 0.3\%$ O₂ at constant temperature and pressure

Combustible Gas: $\pm 3\%$ LEL

Ranges:

Oxygen: 0 to 25% O₂

Combustible Gas: 0 to 100% LEL measurement; 60% LEL maximum alarm set point

Response time (to 90% of full scale):

Oxygen: 20 seconds at 32° to 104°F (0° to 40°C); 3 minutes at 0° to 32°F (-18° to 0°C)

Combustible Gas: 15 seconds at 32° to 104°F (0° to 40°C)

Operating humidity range: 10 to 90% RH

Operating temperature range:

Oxygen: 32° to 104°F (0° to 40°C) (0° to 104°F (-18° to 40°C) if calibrated at temperature of use)

Combustible Gas: 0° to 104°F (-18° to 40°C)

Alarms: High Oxygen, Low Oxygen, and High Combustible Gas Alarms (all adjustable); Off-scale, LEL Latching, and Low Battery Alarms (not adjustable)

Operating

Power supply: Rechargeable, sealed, 4.0-volt lead-acid battery pack

Operating time: 8 to 10 hours with fully charged battery pack

Readouts: 2 analog meters (with automatic protection from shock and vibration damage during transit)

Sample flow rate: Approximately 1.5 liters per minute

Physical

Case construction: Aluminum

Dimensions: 10 x 7 x 3½ in.

Weight: 7½ lb

Accessories: Sample lines up to 50 feet long, liquid line trap, probes, 120 and 240 Vac battery chargers, carrying harness, and calibration kits are available

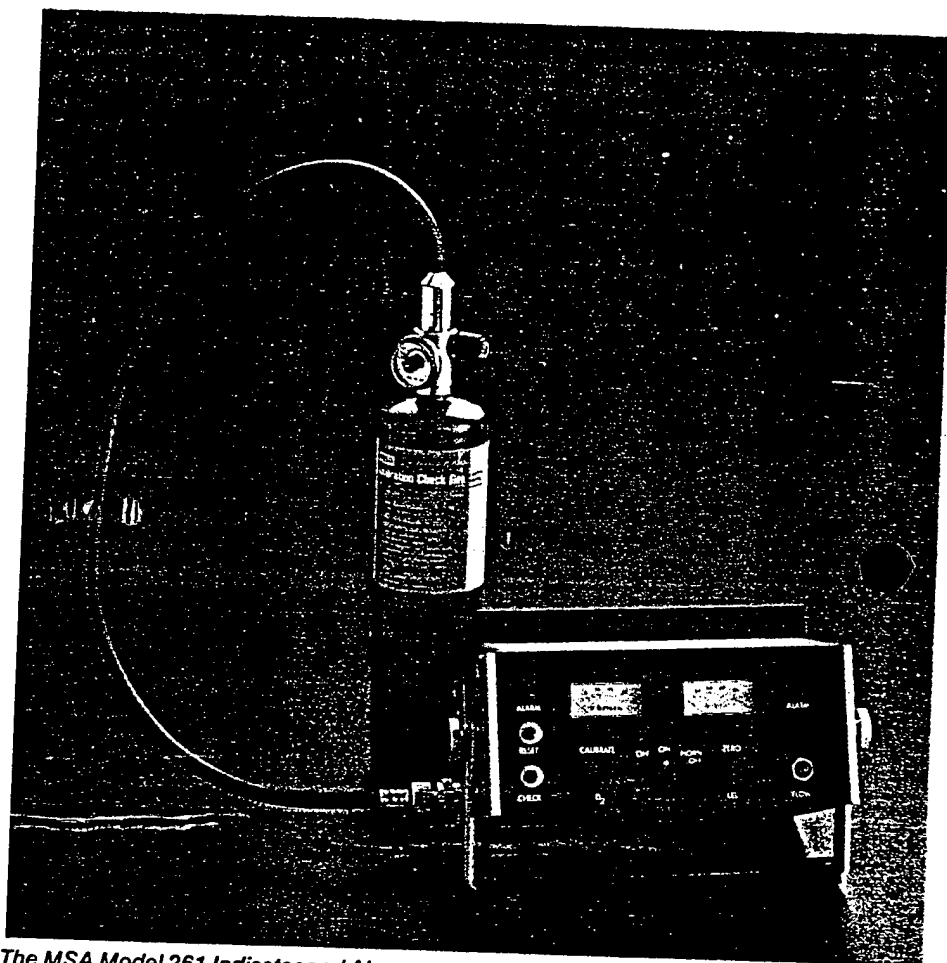
Calibration Check, Model 261

The MSA Calibration Check Kits, Models R and RP provide a quick, convenient and economical method of checking the response of the MSA Model 261 Portable Indicator/Alarm for Oxygen and Combustible Gas. Because testing is performed with known concentrations of pressurized gas-in-air, test results are reproducible.

The Check Kits consist of a flow controlling regulator which includes a gauge to measure container pressure; an adapter

hose with sampling line connection; instructions; and a case fitted with foam for two cylinders of calibration gas.

The cylinders of calibration gas for use with the kits must be ordered separately. They contain a known ($\pm 5\%$ tolerance) concentration of a specified gas mixture. Model R cylinders contain 16 to 20 liters and the larger Model RP cylinders contain 60 to 80 liters of gas, depending on the mixture.



The MSA Model 261 Indicator and Alarm can be easily calibrated using the MSA Calibration Check Kit, Model R.

Ordering information

When ordering Model 261 replacement parts or accessories, please use catalog numbers:

Catalog numbers

476149	Portable Indicator/Alarm for Oxygen and Combustible Gas, Model 261 (requires charger)
631664	Charger, 120 V, 50/60 Hz
631712	Charger, 240 V, 50/60 Hz

Sampling accessories

11354	5-foot synthetic rubber sampling line complete with couplings
11955	10-foot synthetic rubber sampling line complete with couplings
11912	15-foot synthetic rubber sampling line complete with couplings
11913	25-foot synthetic rubber sampling line complete with couplings
11958	50-foot synthetic rubber sampling line complete with couplings
486934	Tube 20-inch, hollow brass probe
11961	Tube, 3-foot hollow brass probe
73743	Tube, 3-foot plastic probe
11960	Rod, 4-foot solid brass probe
14318	Cartridge, charcoal—package of 6
47740	Filter, inhibitor—package of 6
14273	External cartridge holder
74814	Line trap assembly

Miscellaneous accessories

457754	Carrying harness
477153	External charging adapter

Replacement parts

476144	Battery pack
469995	Sample inlet filter element replacement kit
449917	Sensor, combustible gas replacement
457621	Sensor, oxygen replacement
476086	Pump and valve assembly

Calibration accessories

476609	Calibration Check Kit, Model R, with 1.5 L/m regulator—complete—(less calibration gas) including: 459948 Regulator (1.5 L/m) 449401 Adapter hose (with sampling line connection)
476304	Calibration Check Gas (0.75% Pentane, 15.0 % oxygen, in nitrogen)
	OR
477150	Calibration Check Kit, Model RP, with 1.5 L/m regulator—complete—(less calibration gas) including: 467896 Regulator (1.5 L/m) 449401 Adapter hose (with sampling line connection)
478192	Calibration Check Gas (0.75% Pentane, 15.0% Oxygen, balance nitrogen)

Repairs

MSA's strategically located Regional Repair and Service Centers are staffed with specialists who have the knowledge and the equipment to provide testing, calibration, and repair of the Model 261 Indicator/Alarm, with genuine MSA replacement parts. Product modification or repair by anyone other than certified MSA personnel may void warranties and approvals.

Call MSA toll free at 1-800-MSA-2222 for the location of your nearest Service Center.

Note: This Data Sheet contains only a general description of the Portable Indicator/Alarm for Oxygen and Combustible Gas, Model 261. While uses and performance capabilities are described, under no circumstances should the product be used except by qualified, trained personnel and not until the instructions, labels, or other literature accompanying it have been carefully read and understood and the precautions therein set forth followed. Only they contain the complete and detailed information concerning the product.



Offices and representatives in principal cities worldwide.

In U.S. call nearest stocking location toll free at 1-800-MSA-2222. To reach MSA International, call (412) 967-3000 or Telex 812453.

Corporate Headquarters: P.O. Box 426, Pittsburgh, PA 15230 USA.

Data Sheet DA-01-09

Arthur D Little

INSPECTION AND USE OF THE PHOTOVAC MICROTIP HL-200 HAND HELD AIR MONITOR/PHOTOIONIZATION DETECTOR

Written By:	Approved By/Date:	QA Concurrence/Date
L. Kahn	<i>L. Kahn</i> Eric 4/29/93	HIGSON TRIVISZA 4/30/93

This SOP contains nine sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 References
- 4.0 Associated SOPs
- 5.0 Operation
- 6.0 Battery Charging
- 7.0 Storage, Maintenance and Handling
- 8.0 Documentation
- 9.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to provide step-by-step instructions on the proper use, operation, and handling of the Photovac MicroTIP Hand Held Air Monitor/Photoionization Detector, Model HL-200 and Model 2000.

2.0 Application

The Photovac MicroTIP is used as a field screening instrument for detection of total volatile organic (TVO) concentrations in air. Typical uses include air monitoring of the breathing zone for Health and Safety purposes, and ground water and soil screening for TVO emissions.

The Photovac MicroTIP is a highly sensitive instrument with an operating range of 0.1 to 2000 ppm isobutylene equivalent. Its detection limit is 0.1 ppm isobutylene and its response time is less than 3 seconds.

The Photovac MicroTIP is equipped with a 10.6 eV lamp and, therefore, will not detect the presence of methane. However, the presence of methane may dramatically reduce the instrument's ability to detect compounds within its ionization potential. Therefore, this instrument is not recommended as a sole air quality monitor for health and safety issues when elevated levels of methane are suspected. Other lamp sizes, including 11.7 eV, are available for specific applications. The 11.7 eV lamp is

recommended when compounds with ionization potentials greater than 10.6 eV (carbon tetrachloride, 1,1,1-TCA and methanol) are expected.

3.0 Reference

Photovac Incorporated, Instruction Manual, MicroTIP Hand Held Air Monitor, Model HL-200 (attached), or HL-2000.

4.0 Associated SOPs

SOP No. ADL-4014

5.0 Operation

5.1 Pre-use Inspection

The following three pre-use inspection steps will be followed prior to use:

1) Verify that all necessary operation and calibration accessories are included with the instrument:

- one teflon tip extension;
- two batteries;
- two calibration bags (one 0 ppm and one 25 or 100 ppm);
- tubing and connectors to connect the regulator to the bag, and the bag to the MicroTIP;
- one regulator;
- one battery charger;
- one spare lamp (10.6 eV or 11.7 eV);
- spare particulate filters;
- one cylinder of 0 ppm calibration span gas for ambient monitoring; and,
- one cylinder of 25 or 100 ppm calibration span gas.

Selection of 25 or 100 ppm span gas should be made on the basis of whether TVO concentrations are likely to be low (25 ppm) or high (100 ppm).

2) Verify that both batteries are fully charged by completing the following steps:

- Turn on the instrument and allow it to warm up;
- Depress BATT key (a fully charged battery should read approximately 14 volts);
- Turn off instrument and exchange batteries for second battery check; then,

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Date: April 29, 1993
Revision No.: 0
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- Repeat first two steps.

If batteries are low recharge them overnight (see section 6.0)

- 3) Verify that the pump is drawing air freely by quickly placing, then removing, your finger from the air intake and listen for a change in tone. If no tonal change is noted then do not use the instrument and notify the equipment manager immediately.

5.2 Calibration

The Photovac MicroTIP will be calibrated before and after each use and when the battery is changed. Typically, the Photovac MicroTIP is calibrated to ambient air. However, if the quality of the ambient air is suspect, the Photovac MicroTIP is zeroed with 0 ppm span gas (see section 5.2.2).

5.2.1 Ambient Air as a Calibration Standard

When using ambient air as the initial calibration standard, the instrument should be calibrated in a clean area representative of background conditions as follows:

- 1) Turn on the Photovac MicroTIP and allow the instrument to warm up;
- 2) Press CAL on the control keypad;
- 3) Press ENTER;
- 4) Input the correct span gas concentration (25 to 100 ppm) using the control keypad;
- 5) Attach the regulator to the corresponding 25 to 100 ppm span gas cylinder;
- 6) Attach the corresponding 25 to 100 ppm calibration bag to the regulator and fill bag;
- 7) Disconnect the calibration bag from the regulator, pinching the calibration bag extension tube to prevent loss of gas;
- 8) Connect the calibration bag to the MicroTIP intake and press ENTER on the control keypad. When the display reverts to normal, MicroTIP is ready for use.

5.2.2 Total Volatile Organic Free (0 ppm) Span Gas as a Calibration Standard

To measure ambient air the MicroTIP must be calibrated using 0 ppm span gas. The following steps will be used in place of steps 2 and 3 in calibration section 5.2.1:

- 1) Attach the regulator to the 0 ppm calibration span gas cylinder;
- 2) Attach the 0 ppm calibration bag to the regulator;

- 3) Turn on the Photovac MicroTIP, and allow the instrument to warm up;
- 4) Fill the 0 ppm calibration bag, and disconnect the bag from the regulator;
- 5) Pinch the calibration extension tube to prevent loss of gas;
- 6) Press the CAL key on the MicroTIP control keypad;
- 7) Connect the 0 ppm calibration bag to the MicroTIP intake and press the ENTER on the control keypad;
- 8) Continue with steps 5-8 in section 5.2.1.

5.3 Total Volatile Organic Air Monitoring Procedure

When monitoring TVO emissions for health and safety purposes, or for ground water and soil screening, it is necessary to take consistent samples that are representative of the intended objective (i.e., screening of headspace in a well just immediately after it has been opened). This requires always taking samples at the same time interval during the activity, and the same distance away from the sample. In order to have comparable data, outside influences that could effect the instrument's readings, such as exhaust, must be avoided, or noted where unavoidable.

6.0 Battery Charging

The Photovac MicroTIP is powered by a 16 volt battery. The normal operation level is 9-16V, providing approximately 4.0 hours of continuous operation between recharges. The batteries are designed so that it is beneficial to completely drain the battery before recharging. Normal recharging is accomplished by plugging the charger into a 60 Hz outlet. A full battery recharge takes approximately 8 hours.

7.0 Storage, Maintenance, and Handling

MicroTIP must be stored in its case and should be wiped clean as necessary. Keep the intake free of debris and water. If liquids or debris are introduced into the unit, shut the instrument off immediately and clean or dry as described in the manual. Notify the equipment manager of any problems including a low supply of span gas.

8.0 Documentation

For documentation purposes, the time of each MicroTIP calibration must be recorded in the dedicated field notebooks. Observations of varying weather conditions such as temperature and humidity fluctuations will also be recorded. All records will be kept in accordance with Standard Operating Procedure ADL-4014.

9.0 Measure of Proficiency

Personnel must have read the operating manual and have calibrated and used the instrument in the presence of an experienced operator at least twice.

SOP USA-0003 is currently in preparation and not included in this document. In each SOP, a measure of proficiency is given. All field staff will be trained to meet the minimum level of proficiency.

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SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIMES

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(Note: This is a revision of the USATHAMA SOP originally numbered 18.)

1. The conditions specified in the attached Table H-1 must be observed for all USATHAMA samples. (Note that these are USATHAMA-specific requirements which are not necessarily the same as those for EPA or other clients. For non-USATHAMA work, the EPA requirements generally apply.)
2. The holding times specified in the Table represent maximum allowable times to ensure that sample quality is not compromised during collection, shipment, and storage of samples.
3. Extension of holding times beyond those listed in the Table is not acceptable for quantitative analysis according to USATHAMA QC.
4. In cases where Table H-1 indicates that more than one container type is acceptable, selection should be based on availability and durability. All containers must be cleaned prior to use.
5. Sample filtration, when required by a particular method, should be conducted in the field prior to addition of any preservatives. Sample holding time prior to filtration should not exceed 12 hours.
6. All samples collected should be placed in appropriately-sized containers. It is desirable in all cases that the sample containers be filled as completely as possible. It is essential that samples for volatile organic analyses be filled in a manner that allows no head space.

Table H-1. Containers, Preservation, Storage, and Holding Times^a

Parameter	Container ^b		Preservative ^{c,d}		Maximum Holding Time for all Matrices ^e
	Water	Soil	Water	Soil	
INORGANIC TESTS					
Acidity	P	G	Cool, 4°C	Cool, 4°C	14 days
Alkalinity	P	G	Cool, 4°C	Cool, 4°C	14 days
Ammonia	P	G	Cool, 4°C H ₂ SO ₄ to pH <2	Cool, 4°C	28 days
Asbestos	P	G	Cool, 4°C	Cool, 4°C	48 hours ^f
Bicarbonate	P	G	None Required	None Required	Analyze Immediately
Biochemical Oxygen Demand (BOD)					
Carbonaceous BOD	P	G	Cool, 4°C	Cool, 4°C	48 hours
Bromide	P	G	None Required	None Required	28 days
Carbonate	P	G	None Required	None Required	Analyze Immediately
Chemical Oxygen Demand (COD)	P	G	Cool, 4°C H ₂ SO ₄ to pH <2	Cool, 4°C	28 days
Chloride	P	G	None Required	None Required	28 days
Chlorine, Total Residual	P	N/A	None Required	N/A	Analyze Immediately
Color	P	N/A	Cool, 4°C	N/A	48 hours

Table H-1. (Cont'd.)

Parameter	Container ^b		Preservative ^{c,d}		Maximum Holding Time for all Matrices ^e
	Water	Soil	Water	Soil	
Cyanide, Total and Amenable to Chlorination	P	G	Cool, 4°C NaOH to pH >12 0.6 g Ascorbic Acid ^g	Cool, 4°C	14 days ^h
Dissolved Oxygen					
Probe	G Bottle and Top	N/A	None Required	N/A	Analyze Immediately
Winkler	G Bottle and Top	N/A	Fix On Site Store in Dark	N/A	8 hours
Fluoride	P	G	None Required	None Required	28 days
Hardness	P	N/A	HNO ₃ or H ₂ SO ₄ to pH<2	N/A	6 months
Hydrazine	P	G	If not analyzed immediately, collect under acid. Add 90 ml of sample to 10 ml HCl.	Cool, 4°C	7 days
Iodide	P	G	Cool, 4°C	Cool, 4°C	24 hours
Iodine	P	G	None Required	None Required	Analyze Immediately
Kjeldahl and Organic Nitrogen	P	G	Cool, 4°C H ₂ SO ₄ to pH <2	Cool, 4°C	28 days

Table H-1. (Cont'd.)

Parameter	Container ^b		Preservative ^{c,d}		Maximum Holding Time for all Matrices ^e
	Water	Soil	Water	Soil	
Metalsⁱ					
Chromium VI	P	G	Cool, 4°C	Cool, 4°C	24 hours
Mercury	P	G	HNO ₃ to pH <2	Cool, 4°C	28 days
Others	P	G	HNO ₃ to pH <2	Cool, 4°C	6 months
Nitrate	P	G	Cool, 4°C	Cool, 4°C	48 hours
Nitrate plus Nitrite	P	G	Cool, 4°C H ₂ SO ₄ to pH <2	Cool, 4°C	28 days
Nitrite	P	G	Cool, 4°C	Cool, 4°C	48 hours
Oil and Grease	G	G	Cool, 4°C H ₂ SO ₄ to pH <2	Cool, 4°C	28 days
Orthophosphate	P	G	Filter Immediately Cool, 4°C	Cool, 4°C	48 hours
pH	P	G	None Required	None Required	Analyze Immediately
Phenols	G	G	Cool, 4°C H ₂ SO ₄ to pH <2	Cool, 4°C	28 days
Phosphorous, Elemental	G	G	Cool, 4°C	Cool, 4°C	48 hours
Phosphorous, Total	P,G	G	Cool, 4°C H ₂ SO ₄ to pH <2	Cool, 4°C	28 days
Silica, Dissolved or Total	P	G	Cool, 4°C	Cool, 4°C	28 days

Table H-1. (Cont'd.)

Parameter	Container ^b		Preservative ^{c,d}		Maximum Holding Time for all Matrices ^e
	Water	Soil	Water	Soil	
Residue					
Filterable	P	N/A	Cool, 4°C	N/A	7 days
Settleable	P	N/A	Cool, 4°C	N/A	48 hours
Nonfilterable (TSS)	P	N/A	Cool, 4°C	N/A	7 days
Total	P	N/A	Cool, 4°C	N/A	7 days
Volatile	P	N/A	Cool, 4°C	N/A	7 days
Specific Conductance	P	G	Cool, 4°C	Cool, 4°C	28 days
Sulfate	P	G	Cool, 4°C	Cool, 4°C	28 days
Sulfide	P	G	Cool, 4°C Add Zinc Acetate plus NaOH to pH > 9	Cool, 4°C	7 days
Sulfite	P	G	None Required	None Required	Analyze Immediately
Surfactants	P	G	Cool, 4°C	Cool, 4°C	48 hours
Temperature	P	G	None Required	None Required	Analyze Immediately
Turbidity	P	N/A	Cool, 4°C	N/A	48 hours
<u>ORGANIC TESTS^j</u>					
Acrolein and Acrylonitrile	S	S	Cool, 4°C 0.008% Na ₂ S ₂ O ₃ ^g Adjust pH to 4-5 ^k	Cool, 4°C	14 days ^k

Table H-1. (Cont'd.)

Parameter	Container ^b		Preservative ^{c,d}		Maximum Holding Time for all Matrices ^e
	Water	Soil	Water	Soil	
Benzidines ¹	G	G	Cool, 4°C ^m 0.008% Na ₂ S ₂ O ₃ pH 2-7	Cool, 4°C	7 days until extraction ⁿ
Chlorinated Hydrocarbons ¹	G	G	Cool, 4°C	Cool, 4°C	7 days until extraction 40 days after extraction
Haloethers ¹	G	G	Cool, 4°C 0.008% Na ₂ S ₂ O ₃ ^g	Cool, 4°C	7 days until extraction 40 days after extraction
Nitroaromatics and Isophorone	G	G	Cool, 4°C Store in Dark	Cool, 4°C Store in Dark	7 days until extraction 40 days after extraction
Nitrosamines ^{1,o}	G	G	Cool, 4°C Store in Dark 0.008% Na ₂ S ₂ O ₃ ^g	Cool, 4°C Store in Dark	7 days until extraction 40 days after extraction
PCBs	G	G	Cool, 4°C	Cool, 4°C	7 days until extraction 40 days after extraction
Pesticides ¹	G	G	Cool, 4°C pH 5-9 ^p	Cool, 4°C	7 days until extraction 40 days after extraction
Phenols ¹	G	G	Cool, 4°C 0.008% Na ₂ S ₂ O ₃ ^g	Cool, 4°C	7 days until extraction 40 days after extraction
Phthalate Esters ¹	G	G	Cool, 4°C	Cool, 4°C	7 days until extraction 40 days after extraction

Table H-1. (Cont'd.)

Parameter	Container ^b		Preservative ^{c,d}		Maximum Holding Time for all Matrices ^e
	Water	Soil	Water	Soil	
Polynuclear Aromatic Hydrocarbons	G	G	Cool, 4°C 0.008% Na ₂ S ₂ O ₃ ^g Store in Dark	Cool, 4°C Store in Dark	7 days until extraction 40 days after extraction
Purgeable Aromatic Hydrocarbons	S	S	Cool, 4°C 0.008% Na ₂ S ₂ O ₃ ^g HCl to pH < 2 ^q	Cool, 4°C	14 days ^q
Purgeable Halocarbons	S	S	Cool, 4°C 0.008% Na ₂ S ₂ O ₃ ^g	Cool, 4°C	14 days
TCDD ¹	G	G	Cool, 4°C 0.008% Na ₂ S ₂ O ₃ ^g	Cool, 4°C	7 days until extraction 40 days after extraction
Total Organic Carbon	G	G	Cool, 4°C HCl or H ₂ SO ₄ to pH < 2	Cool, 4°C	28 days
Total Organic Halogen	G	G	Cool, 4°C 1 ml of 0.1 M sodium sulfite	Cool, 4°C	7 days

Analytes not listed should be preserved at 4°C and held not longer than 7 days.

^aPreservatives and holding times are from Federal Register, Vol. 49, No. 209, Friday, October 26, 1984, Page 43260 and Characterization of Hazardous Waste Sites: A Methods Manual -- Volume II, Sampling Methods, Second Edition, EPA-600/4-84-076. Container requirements are consistent with these references.

bp = Polyethylene

G = Amber Glass with Teflon-lined cap

S = Glass Vial with Teflon-lined septum cap

c Sample preservation should be performed immediately upon sample collection. For composite samples, each aliquot should be preserved at the time of collection. When use of an automatic sampler makes it impossible to preserve each aliquot, samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.

d When any sample is to be shipped by common carrier or sent through the U.S. Mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements in this table, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation, has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.3 or less).

e Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.

Some samples may not be stable for the maximum time period given in the table. A laboratory is obligated to hold the sample for a shorter time if knowledge exists to show this is necessary to maintain sample integrity.

f If samples cannot be filtered within 48 hours, add 1 ml of a 2.71% solution of mercuric chloride to inhibit bacterial growth.

g Should only be used in the presence of residual chlorine.

h Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustment in order to determine if sulfide is present. If sulfide is present, it can be removed by addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

i For dissolved metals, filter immediately on site before adding preservative.

^jGuidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

^kThe pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within three days of sampling.

^lWhen the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times must be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting pH to 6-9; samples preserved in this manner may be held for 7 days before extraction and 40 days after extraction. Exceptions to this optimal preservation and holding time procedure are noted in footnotes g, m, and n.

^mIf 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to 4.0 ± 0.2 to prevent rearrangement to benzidine.

ⁿExtracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.

^oFor the analysis of diphenylnitrosamine, add 0.008% $\text{Na}_2\text{S}_2\text{O}_3$ and adjust pH to 7-10 with NaOH within 24 hours of sampling.

^pThe pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $\text{Na}_2\text{S}_2\text{O}_3$.

^qSample receiving no pH adjustment must be analyzed within 7 days of sampling.

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COLLECTION AND HANDLING OF SURFACE WATER SAMPLES

Written By:	Approved By/Date:	QA Concurrence/Date:
T. Parkin	<i>M. O. H. H. H.</i> 1/11/93	HILTON RIVERA 1/11/93

This SOP Contains 8 Sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 References
- 4.0 Associated SOPs
- 5.0 Equipment
- 6.0 Procedure
- 7.0 Chain of Custody and Sample Labels
- 8.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to provide a set of guidelines to field sampling personnel responsible for the collection and handling of surface water samples.

2.0 Application

This SOP provides step by step guidelines to be followed by field personnel responsible for the collection and handling of surface water samples.

3.0 References

Refer to specific Survey Plans or Quality Assurance/Work Plans for the scope of work associated with individual surface water sampling programs.

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4.0 Associated SOPs

ADL-1008
ADL-1009
ADL-4014
ADL-1017

5.0 Equipment

The following equipment is required to perform the collection of surface water samples:

- a teflon bailer (for collection of samples at the water surface);
- a stainless steel discrete bomb sampler or Marble sampler (including spare O-rings and gaskets) for collection of water samples from discrete depths within the water column;
- a supply of disposable rope or line;
- chemical resistant gloves;
- calibrated pH, temperature, conductivity, and turbidity meters;
- continuous profile thermometer with depth calibrations
- water proof boots, hip waders, or chest waders;
- stainless steel knife
- position locating equipment including, Brunton compass, stainless steel rods, wooden stakes, flagging, location buoys, a weighted measuring tape and a camera;
- decontamination equipment and supplies;
- coolers and duct tape to ship samples;

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- bubble wrap, ziploc bags, and garbage bags to ship samples;
- all required documentation including a sufficient supply of the appropriate filed forms, field log books, a field sampling notebook, and chain of custody forms;
- a copy of the Field Operations Plan, including, at a minimum, the Field Sampling Plan, the Health and Safety Plan, and the Quality Assurance Plan; and
- all required personal protective equipment and decontamination equipment as specified in the Field Sampling and Health and Safety Plans.

When collecting samples from a boat or barge, the following support equipment is required in addition to the equipment already listed:

- life jackets for all personnel;
- sufficient lighting and flagging, as needed, for compliance with US Coast Guard requirements;
- spare ores as emergency backup in the event of engine failure;
- radio communications with shoreline personnel; and,
- an anchor.

6.0 Procedure

6.1 Sampling Criteria

The following evaluations are to be completed prior to the collection of surface water samples:

- Unless otherwise stated in the Project-Specific Work Plan or Field Sampling Plan, surface water samples are to be taken during periods of moderate flow at a depth of approximately two-thirds the depth below the water surface

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- A vertical temperature profile of the entire water column will be completed for all water columns in excess of 20 feet to determine whether a thermocline exists at the time of sample collection. If the water column at the sample location is of sufficient depth to form a thermocline, sample will be collected from both above and below the thermocline.
- All locations will be approached from a downstream direction to minimize turbidity within the water column; downstream locations will be collected before upstream locations. At locations where sediment samples (ADL SOP 1024) are also scheduled for collection, the corresponding surface water sample will be collected before the sediment sample.
- All sampling equipment will be decontaminated prior to use following the procedure outlined in ADL SOP 1009.
- All sample bottles will be triple rinsed with water representative of that to be sampled prior to being filled with sample
- The pH, temperature, specific conductivity, and turbidity of the sample will be recorded immediately prior to collection

6.2 Collection of Shallow Water (0-4 feet) Samples

Collection of samples in areas of shallow water will be conducted by wading to the sampling location. One member of the sampling team will remain in visual contact with the sampler from the shoreline. All surface water samples will be collected using the stainless steel discrete bomb sampler with the following exception:

- for water column of less than twelve inches, direct submergence of the sample container into the water column is acceptable provided the procedure does not negatively impact the turbidity of the sample

Following collection and distribution, each sample container will be wiped dry and placed on ice in a cooler for the remainder of the days' sampling activities. Following the collection of the sample, the location will be marked by driving a labeled stake into the adjacent bank or shoreline. The position of the sample location will be noted as a range and a bearing to the marked stake. All documentation regarding the sample collection will be made in the field notebook.

6.3 Deep Water Samples (greater than 4 feet)

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Sampling will be conducted from a small boat. The boat will be positioned on the sampling location and the presence of a thermocline will be determined using a continuous profile thermometer. The water depth at the sample location will be determined using a weighted measuring tape and the sample will be collected at the required depth using a stainless steel discrete bomb sampler (as described above) or the Marble Water sampler (described in ADL SOP 1022). Sample handling, storage and sample location documentation will be performed as in described Section 6.2 and 7.0.

7.0 Chain of Custody Forms and Sample Labels

SOP ADL-1017 describes in detail the procedure for filling out sample labels and the Chain of Custody documentation. Sample containers should be prelabeled if possible and the corresponding Chain of Custody Form will be completed before the samples are shipped to the analytical laboratory.

8.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing Sections 6.0 and 7.0 a minimum of twice under the direct supervision of a senior consultant from the Earth Sciences and Engineering Unit (943) or his/her designee.

GROUND WATER MONITORING WELL SAMPLING

Written By:	Approved By/Date:	QA Concurrence/Date
K. Ellingwood	<i>K. Ellingwood</i> 4/29/93	<i>Mary Connell Kozl</i> 4/29/93

This SOP contains ten sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 References
- 4.0 Associated SOPs
- 5.0 Timing and Record Submittal
- 6.0 Equipment
- 7.0 Decontamination
- 8.0 Monitoring Well Sampling Procedure
- 9.0 Documentation
- 10.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to define the standard ground water sampling procedures to be followed by field personnel during the performance of a U.S. Army Environmental Center (USAEC) environmental investigation. More specifically, this SOP provides an outline of information needed to collect and document representative ground water samples for chemical analyses from monitoring wells.

2.0 Application

This SOP applies to the collection of ground water samples which are collected for the purpose of chemical analysis of ground water on USAEC sites.

3.0 References

- "Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports", Department of the Army, USATHAMA, March 1987.
- "Quality Assurance Program", U.S Army Toxic and Hazardous Materials Agency, USATHAMA, Revision 0, January 1990.

- "Basic Contract - Army Total Environmental Program Support", Department of the Army, April 29, 1991.

4.0 Associated SOPs

USA-1001	ADL-1008
ADL-4005	USA-4012
ADL-4014	ADL-5011
ADL-5013	ADL-5020
ADL-5021	

5.0 Timing and Record Submittal

- Ground water sampling may not occur unless well locations have been entered into USAEC Data Management System;
- Monitoring wells will have been surveyed for both elevation and coordinates;
- Ground water sampling point coordinates shall be established within 15 days of the completion of the last well;
- Ground water samples will not be collected earlier than 14 days after well development;
- The source of water to be used for equipment washing must be approved by the PM/COR prior to arrival of sampling team onsite (Refer to "Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports", pages 4-5 for approval details). Allow three calendar weeks from the time of request receipt by USAEC for evaluation and recommendations.

6.0 Equipment

The following equipment is necessary to properly sample a ground water monitoring well:

- A well key or well access equipment;
- A calculator;
- Clean plastic sheeting to protect sampling equipment from ground surface contamination;
- A copy of the Field Operations Plan including at a minimum, the Field Sampling Plan, the Health and Safety Plan, and the Quality Assurance Plan;

- A photo or flame ionization detector to monitor and record the total volatile organic compounds in the well headspace;
- An electric water meter or oil/water interface probe (if free floating product is suspected) calibrated to one one-hundredth of a foot, and sufficiently long to reach the total depth of the well;
- Well purging equipment (e.g., a decontaminated bailer or a submersible or peristaltic pump with sufficient decontaminated tubing and power supply). Where conditions permit, a submersible pump is the preferred purging mechanism;
- A sufficient number of DOT approved 55 gallon drums (including lids, gaskets, and fasteners) to contain all purge water, unless other water handling arrangements have been made;
- Decontaminated sampling bailer(s) or down hole samplers constructed of materials which are chemically compatible with the sampling media and potential contaminants;
- Bailers that are 2.5 inches in diameter or greater shall not be greater than 5 feet in length, and bailers that are less than 2.5 inches in diameter shall not be greater than 7 feet in length;
- Ground water characterization equipment including calibrated temperature, pH, and conductivity meters;
- Calibration solution for all field characterization equipment;
- A sufficient number of sampling containers, prepared according to the USATHAMA Quality Assurance plan and Technical Plan (ELIN A004), including containers for field blanks, duplicates, and matrix spike/matrix spike duplicates;
- All required documentation including sample labels, bound field books, and geotechnical field forms;
- Chemical preservatives for samples as described the project Sampling Plan/Quality Assurance Plan;
- Personnel protective equipment and decontamination equipment as specified in the project Sampling Plan and Health and Safety Plan; and,
- Sampling support equipment (e.g., sample coolers, bubble wrap, clear tape, ice, and self-sealing plastic bags).

7.0 Decontamination

All equipment used to measure and sample the ground water system (e.g., bailers, pumps, tapes, ropes) must be cleaned before use in each well to prevent cross contamination between wells. Equipment that is dedicated to a well site may not require cleaning between sampling events. If the well is free of inflowing sediments, thorough rinsing will be sufficient. When inflowing sediments adhere to equipment, scrubbing may be required in addition to rinsing. In no instance shall detergents, soaps, or solvents be used to clean equipment in the field, unless specific permission is given by USAEC.

Water used for rinsing field equipment shall be bottled distilled water or water from a USATHAMA-approved source. Such approved water should originate from an uncontaminated (background) and untreated source. The water shall be analyzed by a USAEC performance demonstrated laboratory for all project specific analytes prior to collection of field samples. Water from chemical supply companies or retail merchants is acceptable, provided that analysis reveals such water is free of interferences. At least one sample must be submitted to the laboratory and be analyzed for all analytes of interest prior to the first use in the field. The initial rinse water analyses may be done prior to certification approval provided that the analytical procedures used are identical to those tested during certification. A rinse blank shall be included in the initial lot of samples during the initial and subsequent sampling excursions, defined as the time between mobilization and demobilization of the sampling team. Additional rinse blanks shall be taken, as required. Waivers of these requirements will be considered by USAEC Chemistry Branch on a case-by-case basis.

8.0 Monitoring Well Sampling Procedure

Upon arrival at each well, the following procedures shall be followed:

- Suit up in appropriate personal protective equipment as described in the Health and Safety Plan;
- Spread plastic sheeting to protect sampling equipment from ground surface contamination;
- Open well cap;
- Monitor the headspace within the well using the photo or flame ionization detector. This is done by placing the instrument probe at the opening of the well, and recording the reading in the field book and on the appropriate geotechnical field forms;

- Measure and record the ground water surface elevation and well bottom depth using a decontaminated water level meter. All measurements should be taken from the top of the well casing (not protective casing). Elevations of this measuring point should be obtained prior to the sampling event. If free phase product exists within the well, an interface probe may be required to obtain accurate product and water levels. All measurements are to be made in accordance with **ADL-4012**. Measurements are to be made to the nearest one one-hundredth of a foot and recorded in the field notebook and on the appropriate geotechnical field forms;
- Compute the unit purge volume using Monitoring Well Sampling Data Sheet (**ADL-4014**):

$$\text{Unit Purge Volume (Vp)} = [\text{Well Volume (Vw)} + \text{Annulus Volume (Va)}];$$

- Begin to purge well with initial measurement of equifer parameters: temperature, pH, and conductivity (**ADL-5021** for temperature meter operation, **ADL-5013** for pH meter operation, and **ADL-5011** for conductivity meter operation). These measurements will be taken and recorded at the start and at the conclusion of pre-sample purging. Removal of five unit purge volumes (Vp) is required. Purging is complete when five well volumes have been removed and parameters have stabilized to within approximately 10%;
- If the well goes dry during pumping or bailing, one is assured of removing all water which had prolonged contact with the well casing or air. If the recovery rate is rapid, allow the well to recover to its original level and evacuate a second time before sampling. If recovery is very slow, samples may be collected as soon as sufficient volume is available;
- Contain all purge water in DOT approved 55 gallon drums, unless other handling arrangements have been made;
- Both the well and purge drums are to be properly sealed and secured once sampling has been completed. All drums are then permanently labeled as follows:
 - Well location designation
 - Drum contents
 - Date and
 - Estimate of quantity contained therein;
- Record additional information such as unique odors, water color, and a description of suspended particulate content in the field notes and on appropriate geotechnical forms;
- Rinse the sampling bailer once with water drawn directly from the well prior to sample collection. This water will then be discarded to the containment drums;

- Obtain samples for chemical analysis immediately after pumping or bailing is complete. For slow recovery wells, the sample shall be collected immediately after sufficient volume is available. Each bottle and cap shall be rinsed with water from the well at the time of sampling. This rinse should be conducted three times and care should be taken to avoid contamination of the sample from soil or wind blow materials. Collection of the samples should be from a decontaminated sampling bailer. Remove the required amount of water needed to fill the sample bottles, taking caution to minimize disturbance of the well water.
- All samples designated for volatile compound analysis will be collected first (immediately after purging). Fill the sample bottles by pouring the water down the inside of the bottle maintaining laminar flow in order to reduce the volatilization of any contaminants which may be present. Immediately place the lid on the pre-labeled bottles making sure that there are no air bubbles present. Trapped air bubbles will potentially allow dilution of any volatile organic compounds which may be present, thereby resulting in a non-representative sample. Record the sample time on the label and in both the bound field notebook and appropriate geotechnical field forms. For analytical sample labeling and numbering procedures, refer to the Work Plan;
- After obtaining chemical analysis samples, draw a second sample for temperature, conductivity, and pH measurement and record results in the sampling logbook;
- Filter samples, as appropriate; samples to be analyzed for VOCs should never be filtered. Bottles for filtered samples shall be rinsed with filtered sample water and bottles for unfiltered samples should be rinsed with unfiltered sample water;
- Add the required chemical preservations to the sample containers, as described in the Quality Assurance Plan, and cap securely;
- Document and prepare samples for transport in accordance with **USA-1001**, and **USA-1000** and as follows: once the samples have been collected and labeled, each bottle (or set of bottles in the case of VOAs) shall be cleaned by wiping with a paper towel, wrapped in bubble wrap and placed inside a self-sealing plastic bag. All documentation which accompanies samples will also be placed in a self-sealing plastic bag inside a pre-chilled cooler at less than 4 degrees C.

Note: The rinsing requirement specifically precludes adding preservative to bottles before they are shipped to the sampling site. The sampling team must have available the correct preservatives and must be trained in handling and dispensing the preservatives.

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9.0 Documentation

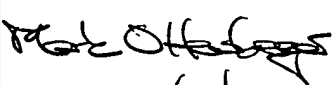
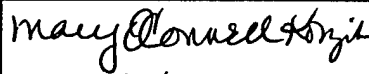
Documentation of all Ground Water Monitoring Well Sampling activities including all field forms and the maintenance of a detailed, bound field notebook are described in **ADL-4014**.

10.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing Sections 7.0, 8.0 and 9.0 a minimum of twice under the direct supervision of a senior consultant from the Remedial Planning Unit (943) on their designee.

SOP No. USA-1025
Date: April 29, 1993
Revision No.: 0
Page 1 of 4

CONCRETE/ASPHALT SAMPLING

Written By:	Approved By/Date:	QA Concurrence/Date
L. Kahn	 4/29/93	 4/29/93

This SOP contains 9 Sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 References
- 4.0 Associated SOPs
- 5.0 Equipment
- 6.0 Decontamination
- 7.0 Concrete/Asphalt Sampling Procedure
- 8.0 Documentation
- 9.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to define the standard concrete/asphalt sampling methods and procedures to be followed by geotechnical field personnel during the performance of a United States Army Environmental Center (USAEC) environmental investigation.

2.0 Application

This SOP provides a step-by-step guideline to be followed by geotechnical field personnel responsible for performing or overseeing concrete/asphalt sampling procedures on USAEC projects.

3.0 References

- ASTM Method D75 (4.02, 4.03, 4.08)

4.0 Associated SOPs

ADL-1009

ADL-4014

5.0 Equipment

The following equipment is necessary to properly perform concrete/asphalt sampling:

- a diamond core drill;
- a chisel and hammer;
- a wooden folding ruler;
- all required documentation including field books;
- a copy of the Field Operations Plan including the Field Sampling, Health and Safety, and Quality Assurance Plans; and
- personnel protective equipment and decontamination equipment as specified in the project Sampling, and Health and Safety Plans.

6.0 Decontamination

All equipment which will come in contact with the concrete material will be decontaminated prior to arrival on site, relocation on site, and site exit. Standard Operating Procedure ADL-1009 is to be followed for all metal sampling equipment.

7.0 Concrete Chlp Sampling Procedures

Concrete/asphalt sampling shall proceed according to the following procedures upon arrival at each location:

- Suit up in appropriate personal protective equipment as described in the site Health and Safety Plan;
- Spread plastic sheeting to protect sampling equipment from ground contamination;

- Note in the field notebook whether the concrete/asphalt is fine or coarse, whether it is painted, and if there are any obvious discolored surfaces;
- Set up a sampling grid pattern or mark the sampling locations accordingly. If sampling for the disposal of the concrete/asphalt material, the samples are to be collected along an appropriately sized grid pattern. If sampling for the verification of a spill, the samples are to be collected from obvious discolored surfaces or within proximity to the area where the spill had occurred;
- Decontaminate the appropriate equipment in accordance with SOP No. USA-1008 in preparation for sampling. A diamond core drill should be used to obtain cylindrical concrete core samples. If sampling for volatile organic analysis, however, use a chisel and hammer to obtain chip samples (DO NOT use a core drill as the heat generated by the drill will cause the volatiles to dissipate). If sampling asphalt, a chisel and a hammer will suffice as the material is sufficiently soft;
- Collect the core/chip samples perpendicular to a horizontal surface, either from cinder blocks on the walls or from the concrete/asphalt slab of the floor. If sampling cinder blocks, the samples should be collected from the center of the blocks. If sampling concrete/asphalt slabs, the samples should be taken from the middle of the sample quadrant and not near formed joints or obvious edges;
- All cores or chipped areas should be approximately 1 inch in diameter regardless of the sampling intent or method used. The length of the core or the depth of the chipped area is dependent upon the intent of sampling. If sampling for the verification of a spill, collect the sample from 0 - 1 inch or to the extent of discoloration; if sampling for material disposal, collect the sample from 0 - 3 inches;

NOTE: The core drill is lubricated with oil. Be sure that no oil gets near the samples or areas to be sampled.

- Sample preparation must be discussed with the laboratory prior to acquisition of the samples. Typically, the laboratory shall crush and mix each sample appropriately to ensure representative aliquots for the various analytical procedures, thus requiring no further measures to be taken in the field.
- The use of water may be needed to reduce heating of the core drill; minimize sparking and fly-away cuttings; or lubricate the corehole while drilling. If water is used, the source and volume of water should be documented.

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8.0 Documentation

Documentation of all concrete/asphalt sampling activities including the maintenance of a detailed field notebook are described in **ADL-4014**.

9.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing Sections 6.0, 7.0, and 8.0 a minimum of twice under the direct supervision of a senior consultant from the Remedial Planning Unit (943) or their designee.

SOP USA-3000 is currently in preparation and not included in this document. Specific procedures for chemical and sample disposal are given in the Work Plan.

SOP No. USA-4001
Date: October 6, 1992
Revision No.: 0
Page 1 of 10

EXPLORATORY BORING PROCEDURES

Written By:	Approved By/Date:	QA Concurrence/Date
L. Kahn	<i>R N Kahn</i> 10-15-92	HILTON RIVERA 11-10-92

This SOP contains 17 Sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 References
- 4.0 Associated SOPs
- 5.0 Timing and Record Submittal
- 6.0 Equipment
- 7.0 Certifications and Inspections
- 8.0 Subsurface Clearance
- 9.0 Decontamination
- 10.0 Site Geologist
- 11.0 Drilling Methods
- 12.0 Drilling Procedures
- 13.0 Materials
- 14.0 Multiple Aquifer Penetrations
- 15.0 Bore Hole Abandonment
- 16.0 Documentation
- 17.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to define the standard exploratory boring methods and procedures to be followed by the site geologist and drilling contractor during the performance of a U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) environmental investigation. More specifically, this SOP will define procedures to be used for drilling both unconsolidated overburden and bedrock media, and through both multiple aquifers separated by impermeable stratigraphic units and unconfined surficial aquifers.

2.0 Application

This SOP applies to both the advancement of exploratory bore holes and holes which are drilled for the purposes of monitoring wells on USATHAMA sites.

Arthur D Little

3.0 References

- "Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports", Department of the Army, USATHAMA, March 1987, pgs. 2-17.

4.0 Associated SOPs

ADL-1008	ADL-1009
USA-4002	USA-4003
USA-4009	ADL-4014
ADL-5012	

5.0 Timing and Record Submittal

5.1 Prior to Onsite Arrival

- Refer to Section 7.0 for all local and state certifications, permits, and licenses to be secured by Arthur D. Little prior to arrival onsite;
- allow six working days from the time of receipt of the bentonite approval request by the USATHAMA Project Manager (PM)/Contracting Officer Representative (COR) for request evaluation and recommendations (refer to Section 13.1 of this SOP);
- allow three calendar weeks from the time of receipt of the water approval request by the PM/COR for request evaluation and recommendations (refer to Section 13.2 of this SOP).

5.2 During Drilling Operations

- Allow four consecutive hours from the time of request for approval of unscheduled bore hole abandonments for PM/COR evaluation and decisions. A written followup memorandum shall be submitted by Arthur D. Little within five working days (refer to Section 15.0 of this SOP);
- each original boring log and geotechnical field form regarding exploratory boring operations (refer to Section 16.0 of this SOP) shall be submitted directly from the field to the PM/COR within three working days after boring completion. In those cases where a monitor well or other instrument is to be inserted into the boring, all appropriate field forms must be submitted within three working days after the monitoring well or instrument is installed. ONLY the original geotechnical field

forms shall be submitted. Carbon, typed, or reproduced copies are not permitted.

6.0 Equipment

The following equipment should be provided and maintained by the site geologist:

- a calibrated photo or flame ionization detector;
- a weighted, fiberglass tape calibrated to a hundredth of a foot and of sufficient length to reach the bottom of the deepest bore hole;
- a wooden folding ruler calibrated to a hundredth of a foot;
- an electric water meter, immiscible phase probe, or chalked steel tape for obtaining water level measurements to an accuracy of a hundredth of a foot;
- an appropriate array of chemical sample bottles and labels;
- a 10x hand lens;
- a Munsell Color Chart;
- a copy of the Unified Soils Classification System;
- all required documentation including a sufficient supply of the appropriate geotechnical field forms and field notebooks;
- a stainless steel knife;
- a stainless steel bowl and spoon;
- a sufficient number of DOT approved 55 gallon drums (including lids, gaskets, and fasteners) to contain all drill spoils, unless other arrangements have been made;
- a copy of the Field Operations Plan including at a minimum, the Field Sampling Plan, the Health and Safety Plan, and the Quality Assurance Plan; and
- all required personnel protective equipment and decontamination equipment as specified in the project Sampling, and Health and Safety Plans;

The drilling contractor is responsible for providing the following:

- all drilling equipment and accessories needed to fulfill the requirements set fourth in the proposed Scope of Work (e.g., decontaminated 24-inch split spoon samplers, steam cleaners, circulation tanks, grout plants, core barrels, and;or a sufficient number of appropriate diameter augers or casing to reach the maximum anticipated bore hole depth);
- copies of required permits, licenses, and certificates;
- core boxes and geotechnical sample jars; and
- all required personnel protective equipment as defined in the Health and Safety Plan.

7.0 Certifications and Inspections

Prior to arrival at the site, Arthur D. Little shall have secured and complied with any and all boring and/or well drilling permits and/or procedures and/or well log and sample submission regulations required by the state or local authorities. Compliance with the submission of the well logs and samples, if required, shall be coordinated with USATHAMA. Any rights-of-entry for off-post drilling shall be obtained and supplied to Arthur D. Little by the PM/COR. Arthur D. Little will collect copies of all required permits, licenses, and certifications from the drilling contractor. A copy of these permits, licenses, and certifications (denoting expiration date) shall be provided in Arthur D. Little's Field Operations Plan.

Upon arrival at the site, an informal inspection will also be conducted to confirm that all personnel protective equipment required in the Health and Safety Plan has been provided by the driller, for the driller, and to assess the overall cleanliness of the drill rig and accessories. Any observed contamination of the drill rig by dirt, grease, gasoline, or hydraulic fluids must be removed by steam cleaning prior to initiation of the drilling. Additionally, any fluid leaks identified will be corrected prior to initiation of the drilling.

8.0 Subsurface Clearance

Arthur D. Little shall be responsible for determining and complying with any and all regulations, requirements, and permits with regard to underground utility detection. All knowledgeable parties must approve the bore hole location to assure risk minimization with respect to encountering unexpected subsurface hazards and obstacles. In cases where information on subsurface conditions is limited, subsurface clearance may require confirmation using geophysical ground penetrating radar, magnetics, or other appropriate techniques to assure safety.

9.0 Decontamination

All equipment which will come in contact with the bore hole and/or well water will be decontaminated prior to arrival on site, relocation on site, and site exit. Standard Operating Procedures **ADL-1008** (for Teflon and glass) and **ADL-1009** (for metal) are to be followed.

10.0 Site Geologist

A geologist shall be present and responsible at each operating drill rig for the monitoring of drilling operations, collection and logging of geotechnical and chemical samples, recording of any loss of water during the drilling processes, the recording of any water loss/gain and groundwater data, preparing the appropriate geotechnical field forms (refer to Section 16.0 of this SOP), and recording the bore hole abandonment or well installation procedures of that rig. In addition, the site geologist must monitor and record the volatile organics present at the bore hole and in the breathing zone of the surrounding area with a photo or flame ionization detector, as specified in the project Health and Safety Plan. All measurements obtained with a photo ionization detector should be made in accordance with **ADL-5012**. Each geologist shall be responsible for only one operating rig.

11.0 Drilling Methods

This section defines the preferred drilling method(s) to be used when penetrating specific stratigraphic units;

Clay to Gravelly Sand	Hollow Stem Auger
Coarse Gravel and Cobbles	Drive and Wash (Water Rotary)
Bedrock	Roller/Tricone Bit Diamond Coring Bit (see SOP USA-4009)

When coarser sediments are encountered beneath finer sediments during augering, thus resulting in substantially reduced auger penetration, it is usually possible to continue by running casing through the augers and converting to the drive and wash drilling technique.

At no time will air or mud rotary techniques be considered as acceptable drilling

methods for an environmental investigation. This is because the nature of both methods typically result in the redistribution of potentially present contaminants and may reduce the likelihood of acquiring representative data. Additionally, air rotary drilling significantly increases the potential for worker contaminant exposure, and mud rotary drilling typically, irreversibly, alters the hydraulic characteristics of the various stratigraphic units in the immediate vicinity of the bore hole.

12.0 Drilling Procedures

12.1 Hollow Stem Auger Drilling

Hollow stem augering is the preferred drilling procedure for environmental investigations. The advantage of this procedure is that there is a minimal impact on the local hydrology because little to no water is added to the system which could alter the local chemical compositions. Additionally, the nature of this technique minimizes changes to the hydraulic conductivity properties of the penetrated stratigraphic units. However, potentially contaminated materials are collected on the ground surface and contact with these materials should be minimized. This is done by either shoveling the drill spoils out of the way by placing them under the rig or, in circumstances where hazardous materials are encountered, shoveling the drill spoils directly into DOT approved 55 gallon steel drums.

This procedure entails advancing the augers into the subsurface using hydraulic pressures. Both the rotation of the augers during advancement and the screw-like orientation of the auger flights result in sediments being removed from the path of the auger and transported to the ground surface. Typically, a plug attached to a series of drill rods is advanced simultaneously down the center of the augers to prevent the augers from filling up with sediment. If split spoon sampling is to be conducted, the plug is removed, the sample is taken in accordance with SOP USA-4002, and the plug replaced prior to connecting the next auger segment. Typically, hollow stem augers are advanced in 5.0 foot increments (which correspond to the lengths of the auger flights), however the advancement increments are site specific. An accurate account of bore hole depth and water loss should be maintained by the site geologist at all times (refer to Section 10.0 for the site geologist responsibilities during drilling procedures).

12.2 Drive and Wash (Water Rotary) Drilling

In cases where coarse grained strata, or bore hole depths in excess of 55 feet are anticipated, hollow stem augering may be an inappropriate drilling method. In these cases, the drive and wash drilling technique is preferred. This drilling procedure entails driving an appropriate diameter hollow steel casing into the subsurface using a

300 pound weight. This is followed by breaking up the subsurface material inside the casing with a roller/tricone bit and then flushing the material out of the casing using water.

A recirculation water tub is required during the performance of this drilling technique. A portable recirculation tub and water tank will be used. The use of dug sumps/pits are strictly prohibited.

Once the sediment has been removed from the length of the casing and the split spoon samples have been obtained in accordance with SOP USA-4002, a new segment of casing is attached and the procedure is repeated until the desired depth is achieved. Typically, the steel casing is advanced in 5.0 foot increments (which correspond to the typical casing lengths), however the advancement increments are site specific. An accurate account of bore hole depth and water loss should be maintained by the site geologist at all times (refer to Section 10.0 for the site geologist responsibilities during drilling procedures).

When the rate of penetration of the casing is significantly reduced due to the coarseness or density (high compaction) of the strata, it may be necessary to drill ahead, then drive the casing. This method is less than desirable for bore holes which are intended for monitoring well installations; however, in some cases this is unavoidable. The disadvantage with this reversal of drilling sequences is that any water introduced into the system is unconfined and in direct communication with the various stratigraphic units, thus resulting in a loss of water and a potential diluting of chemical constituents. The amount of water used should be minimized and carefully tracked during this procedure.

12.3 Roller/Tricone Drilling

This drilling procedure is intended for bedrock drilling and does not require the use of casing. It is the equivalent to the technique used for removing sediments from the steel casing in the drive and wash method (refer to Section 12.2 for roller/tricone bit procedure and recirculation tub/tank requirements). In cases where an unconsolidated overburden is present above the bedrock, one of the above mentioned procedures should be followed prior to initiation of this technique. Typically, the drill rods are advanced in 5.0 foot increments. All bedrock core samples will be collected in accordance with SOP USA-4009. An accurate account of bore hole depth and water loss should be maintained by the site geologist at all times (refer to Section 10.0 for the site geologist responsibilities during drilling procedures).

13.0 Materials

The usage of the below mentioned materials and any other drilling/well construction materials which potentially could have a bearing on subsequent interpretation of the analytical results must be summarized in the field notebook and on the appropriate geotechnical field forms (**ADL-4014**).

13.1 Bentonite

Bentonite is the only drilling fluid additive allowed. No organic additives shall be used. The use of any bentonite, including powders, pellets, etc., intended for grout, seals, etc. must be approved by the PM/COR prior to the arrival onsite of the drilling equipment (refer to "Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports", pgs. 4-5 for approval details). Allow six working days from the time of request receipt by USATHAMA for evaluation and recommendations.

13.2 Water

The source of any water to be used in any drilling, grouting, sealing, filter placement, well installation, or equipment washing must be approved by the PM/COR prior to arrival of the drilling equipment onsite (refer to "Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports", pgs. 5-6 for approval details). Allow three calendar weeks from the time of request receipt by USATHAMA for evaluation and recommendations.

13.3 Grout

Refer to SOP **USA-4003** for grout criteria and the methods for use during the exploratory boring procedures.

13.4 Miscellaneous Materials

- Only petroleum jelly, teflon tape, lithium grease, or vegetable-based lubricants shall be used on the threads of downhole drilling equipment. Additives containing lead or copper shall not be used. Any hydraulic or other fluids in the drilling rig, pumps, or other field equipment/vehicles shall NOT contain any polychlorinated biphenols (PCBs);
- if antifreeze is added to any pump, hose, etc., in an area in contact with drilling fluid, this antifreeze shall be completely purged prior to the equipment's use in drilling or any other part of the overall drilling operation. Only antifreeze without rust inhibitors and/or sealants shall be used. The dates, reasons, quantities, and brand names of antifreeze shall be noted on the appropriate boring logs;

- surface runoff (e.g. precipitation, wasted or spilled drilling fluid, and miscellaneous spills and leaks) shall not enter any boring or well either during or after drilling. The use of starter casing, recirculation tanks, berms about the bore hole, and surficial bentonite packs, as appropriate, should be used;
- tracers, dyes, or other substances shall not be used or otherwise introduced into borings, wells, grout, backfill, ground water, or surface water unless specifically required by the project contract.

14.0 Multiple Aquifer Penetrations

Frequently there is a need to sample or install wells in confined aquifers which underlie surficial aquifers. In these situations it is important to conduct a geophysical survey of the area in order to accurately define the depth and thickness of the confining layer prior to initiating a drilling program. Once the various stratigraphic units have been defined, the following procedure will be applied.

In an effort to minimize the potential for cross contamination between high permeable zones (aquifers) separated by low permeability zones (aquicludes), the following drilling procedure will be applied:

- a large diameter hole will be advanced through the first zone of high permeability and approximately 5.0 feet (or appropriately determined distance) into the underlying aquiclude;
- a large diameter steel casing will be driven to the bottom of the bore hole and cemented in place from the bottom and allowed to set over night;
- after the cement has dried, a smaller diameter hole will be drilled through the cement and down to the next aquifer.

15.0 Bore Hole Abandonment

Once a bore hole has been advanced to its final depth and all samples have been collected, and a monitoring well is not intended for installation, the bore hole must be properly abandoned. Proper abandonment implies that the bore hole will not provide a vertical conduit for contaminant transport. Each bore hole requiring abandonment will be abandoned grouted from the bottom up in accordance with SOP USA-4003, and documented in accordance with SOP ADL-4014.

The abandonment of any borings or wells not scheduled for abandonment per

contract, must be approved by the PM/COR prior to any casing removal, sealing, or backfilling (refer to "Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports", pg. 8 for approval details). Allow four consecutive hours from the time of request receipt by USATHAMA for evaluation and decision. A written followup memorandum shall be submitted by Arthur D. Little within five working days of the request.


16.0 Documentation

Documentation of all exploratory boring activities including the completion of all geotechnical field forms, and the maintenance of a detailed field notebook will be conducted as described in **ADL-4014**.

17.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing Sections 9.0, 10.0, 11.0, 12.0, 14.0, 15.0, and 16.0 a minimum of twice under the direct supervision of a senior consultant from the Remedial Planning Unit (943) or their designee.

STANDARD PENETRATION TESTS AND SPLIT SPOON SAMPLING

Written By:	Approved By/Date:	QA Concurrence/Date
L. Kahn	 10-15-92	HILTON RIVERA 11-10-92

This SOP contains 11 Sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 References
- 4.0 Associated SOPs
- 5.0 Timing and Record Submittal
- 6.0 Equipment
- 7.0 Decontamination
- 8.0 Standard Penetration Test Procedures
- 9.0 Split Spoon Sampling Procedures
- 10.0 Documentation
- 11.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to provide geotechnical field personnel with an outline of the specific information needed to conduct and document standard penetration tests and split spoon sampling on U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) sites.

2.0 Application

This SOP provides a step-by-step guideline to be followed by the site geologist when performing standard penetration tests and obtaining split spoon samples during drilling operations on USATHAMA sites.

3.0 References

- "Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports", Department of the Army, USATHAMA, March 1987, pgs. 10-11.

4.0 Associated SOPs

ADL-1009	ADL-4014
ADL-5012	USA-1000
USA-1001	

5.0 Timing and Record Submittal

Each original boring log and geotechnical field form regarding standard penetration tests and split spoon sampling (refer to Section 10.0 of this SOP) must be submitted to the USATHAMA Project Manager (PM)/Contracting Officer Representative (COR) within three working days after boring completion. In those cases where a monitor well or other instrument is to be inserted into the boring, all appropriate field forms must be submitted within three working days after the instrument is installed. **ONLY** the original geotechnical field forms shall be submitted. Carbon, typed, or reproduced copies are not permitted.

6.0 Equipment

The following equipment is required to properly conduct standard penetration tests and split spoon sampling from soil borings:

- a photo or flame ionization detector;
- a rigid two foot ruler calibrated to a hundredth of a foot;
- a stainless steel, 24-inch split spoon sampler, including steel sample traps;
- a Munsell Color Chart;
- a copy of the Unified Soil Classification System;
- a 10x (minimum) hand lens;
- a stainless steel bowl, spoon, and knife;
- geotechnical and chemical sample bottles, including labels;
- all required documentation including a sufficient supply of the appropriate geotechnical field forms and field notebooks; and
- all personal protective and decontamination equipment as specified in the project

Sampling, and Health and Safety Plans.

7.0 Decontamination

All equipment which will come in contact with the subsurface and/or be used to acquire a sample will be decontaminated prior to arrival on site, between samples, and site exit. Standard Operating Procedure **ADL-1009** for metals shall be followed.

8.0 Standard Penetration Test (SPT)

Engineering and physical properties of soil may be of interest should site construction activities be planned. Soil types, bearing strength, compressibility, permeability, plasticity, and moisture content are some of the physical characteristics that may be determined on soil samples. The ASTM Standard Penetration Test (SPT) is an important component in identifying some of these characteristics (e.g., relative density, compactness, and cohesiveness). The following procedure must be followed in order to conduct the SPT:

- attach a decontaminated 24 inch split spoon sampler to the appropriate length of drill rods and gently lower the sampler to the bottom of the bore hole (the spoon should only be handled while wearing a clean pair of personnel protective gloves in order to reduce the risk of contamination). The spoon should be resting on undisturbed soil at the upper boundary of the soil interval to be sampled;
- mark 6 inch increments on the drill rod upward from a rigid surface datum (e.g., ground surface or hollow stem auger drill casing), for a length of 24 inches;
- drive the split spoon into the soil using a certified 140 lb. hammer dropped consistently from a height of 30 inches;
- count and record the number of blows struck by the hammer for each six inch increment of penetration;
- the test is completed when either the spoon has been driven 24 inches or when 100 blows are counted within a 6 inch increment before the complete 6 inch penetration of the increment has been obtained (refusal); and
- if refusal occurs at anytime during the test, record the number of blows counted for each 6 inch increment penetrated prior to refusal, and then 100 blows per the amount of penetration (to the nearest hundredth of a foot) attained during the final increment.

In situations where the weight of the drill rods (w/r) or the weight of the hammer and drill rods together (w/h) is sufficient to drive the split spoon into the soil without inflicting blows from the hammer, this should be recorded on the Soil Boring Logs as "w/r" or "w/h" for each applicable 6 inch increment.

9.0 Split Spoon Sampling Procedure

Subsurface soil samples are collected in order to accurately characterize local stratigraphic compositions and interfaces, and for the collection of chemical samples at specific depths.

The following procedures for retrieving and logging a subsurface soil sample via split spoon sampling shall be followed:

- in preparation for sampling, prepare all appropriate sample bottles in accordance with SOP USA-1000, and label all bottles accordingly. Spread out a clean sheet of aluminum foil, shiny side down;
- 24 inch split spoon soil samples will be collected at ground surface and at 5.0 foot intervals, unless otherwise indicated in the Sampling Plan;
- the SPT will be conducted for each sample and the blows, together with the location name, date, and depth, are recorded on the geologic bottle label and on the appropriate geotechnical field forms;
- upon completion of the SPT, the split spoon is brought to the surface, removed from the drill rods, and placed on the aluminum foil;
- the split spoon sample will be opened and immediately screened for volatile organics by the site geologist using a calibrated photo or flame ionization detector. Volatile organic measurements are made by placing the instrument probe approximately 1.5 inches from the sample core and slowly passing the probe over the length of the sample. All measurements obtained with a photo ionization detector should be made in accordance with ADL-5012. In the event that chemical samples are being collected for volatile organics, the site geologist should proceed as quickly as possible;
- record the highest reading obtained for that split spoon sample in the field notebook and on the appropriate geotechnical field forms;

If chemical samples are to be collected:

- samples to be collected for volatile organic analysis must be bottled and capped within 15 seconds from the time of opening the split spoon. This shall be conducted by collecting **ONLY** the portion of the sample that was not in direct contact with the sampler nor the ends of the sample. Be sure to collect the sample from all representative portions of the spoon;
- remove the ends of the sample and all portions of the sample that were in direct contact with the sampler;
- transfer the remainder of the soil into a stainless steel bowl and mix the soil well with the spoon, to composite the sample. Transfer the composited soil into the appropriate chemical sample bottles. NOTE: samples to be collected for physical soil testing (eg., grain size distribution, Atterberg Limits, etc.) should be collected prior to compositing, by placing a representative portion of each stratigraphic unit identified within the split spoon into the appropriate bottle;
- in the event that enough soil remains after aliquots for chemical analysis are taken, place a portion of the remaining soil into a geologic jar and cover the mouth of the jar with aluminum foil. Allow this sample to sit for at least 10 minutes;

If no chemical samples are to be collected:

- place a representative portion of each stratigraphic unit identified within the split spoon into a geologic sample jar for possible future geological reference. Cover the mouth of the jar with aluminum foil. Allow the samples to sit for at least 10 minutes;

After all sample aliquots are collected:

- record the amount of sample recovered, depth of stratigraphic changes, and a detailed description of each stratigraphic unit identified as required on the appropriate geotechnical field forms (SOP **ADL-4014**);
- place the chemical sample bottles in a cooler with ice and log them in on the appropriate sample documentation custody form and notebook, in accordance with SOP **USA-1001**;
- monitor the headspace within the geologic samples using a photo ionization detector. This is done by opening the sample jar, placing the instrument probe through the covering aluminum foil, and recording the reading in the field book

and on the appropriate geotechnical field forms. All headspaces obtained with a photo ionization detector should be made in accordance with **ADL-5012**;

- upon completion of the above procedures, any remaining portion of the sample may then be discarded as specified in the Sampling Plan and the split spoon is to be decontaminated according to Standard Operating Procedure **ADL-1009**.

10.0 Documentation

Documentation of all standard penetration tests and split spoon sampling activities including the completion of all geotechnical field forms and the maintenance of a detailed field notebook will be conducted as described in Standard Operating Procedure **ADL-4014**, by a site geologist.

11.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing Sections 7.0, 8.0, 9.0, and 10.0 a minimum of twice under the direct supervision of a senior consultant from the Remedial Planning Unit (943) or their designee.

GROUT METHODS AND CRITERIA

Written By:	Approved By/Date:	QA Concurrence/Date
L. Kahn	<i>R. W. Danks</i> 10-15-92	HILTON RIVERA 11-10-92

This SOP contains 10 Sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 References
- 4.0 Associated SOPs
- 5.0 Equipment
- 6.0 Decontamination
- 7.0 Grout Composition
- 8.0 Grouting Procedures
- 9.0 Documentation
- 10.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to provide geotechnical field personnel responsible for any U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) site activities in which the use of grout is employed, with a set of guidelines to assure the adherence to proper grout criteria and methods.

2.0 Application

This SOP is binding to all activities where the specific use of grout is identified in the site Work Plan. Absolutely NO deviation of this SOP can be made in the field without prior approval from the USATHAMA Project Manager (PM)/Contracting Officer Representative (COR).

3.0 References

- "Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports", Department of the Army, USATHAMA, March 1987, pgs. 6-8.

4.0 Associated SOPs

ADL-4014

5.0 Equipment

- An above-ground rigid container or mixer;
- a commercially available grout pump specifically manufactured to pump cement grouts;
- tremie pipe of rigid, not flexible, construction. Drill rods, rigid polyvinyl chloride (PVC) or metal pipes are acceptable tremies, while hoses and flexible PVC are unacceptable; and
- sufficient amounts of Portland cement (type II or V), approved bentonite, and approved water (refer to "Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports" pgs. 4-6 for approval details).

6.0 Decontamination

All equipment which will come in contact with the grout will be steam cleaned prior to arrival on site, relocation on site, and site exit.

7.0 Grout Composition

Grout, when used in the installation of data acquisition equipment (eg., monitoring wells, piezometers, etc.) or bore hole/well abandonment, shall be composed by weight of 20 parts Portland cement and up to 1 part approved bentonite, combined with a maximum of 8 gallons of approved water per 94 pound bag of cement. Neither additives nor bore hole cuttings shall be mixed with the grout. Bentonite shall be added after the required amount of cement is mixed with water.

8.0 Grouting Procedures

Upon arrival at each grouting activity, procedures shall be performed as follows:

- all grout materials shall be combined, in accordance with Section 7.0 of this SOP, in an above-ground rigid container or mixer and mechanically, NOT manually,

blended on site to produce a thick, lump free mixture throughout the mixing vessel;

- the mixed grout shall be recirculated through the grout pump prior to placement;
- a rigid tremie pipe shall be positioned just above the bottom of the bore hole (for bore hole and well abandonment) or just above the top of the bentonite seal if data acquisition equipment is installed. The proper positioning of the tremie pipe is critical, as grout placement via gravity and the grout head using an elevated grout tank is strictly prohibited;
- the grout shall be pumped through this pipe, through the use of the grout pump, to the bottom of the open annulus until undiluted grout flows from the annulus at ground surface forming a continuous grout column from the bottom of the bore hole or the top of the seal to the ground surface. The grout shall NOT penetrate the well screen or granular filter pack, and disturbance of the bentonite seal should be minimal;
- if field conditions permit, the contractor may incrementally place grout and remove drill casing or augers so as to constantly maintain 10 feet of grout (minimally) within the casing yet to be removed from the ground. Using this method requires at least 20 feet of grout to be within the casing/augers before removing 10 feet of casing/augers. The drill casing or hollow stem augers shall then be removed from the bore hole, and more grout immediately added to compensate for settlement;
- if drill casing or augers were not used, proceed with grouting to ground surface in one, continuous operation;
- after 24 hours, Arthur D. Little shall check the site for grout settlement and that day add more grout to fill any settlement depression. This process is to be repeated until firm grout remains at the surface;
- volumes of each grouting segment will be documented by the designated site geologist in a field notebook and on the appropriate geotechnical field forms in accordance with SOP ADL-4014;
- for grout placement at less than ten feet in a DRY hole, the grout may be poured in place from ground surface.

9.0 Documentation

Documentation of all grouting activities including all geotechnical forms and the

maintenance of a detailed field notebook are described in ADL-4014.

10.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing or overseeing Sections 6.0, 7.0, 8.0, and 9.0 a minimum of twice under the direct supervision of a senior consultant from the Remedial Planning Unit (943) or their designee.

GROUND WATER MONITORING WELL INSTALLATION

Written By:	Approved By/Date:	QA Concurrence/Date
K. Ellingwood	<i>Mark O'Hedra</i> 4/29/93	<i>Mary Donnell Kozik</i> 4/29/93

This SOP contains ten sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 References
- 4.0 Associated SOPs
- 5.0 Timing and Record Submittal
- 6.0 Installation Equipment and Materials
- 7.0 Monitoring Well Installation Procedure
- 8.0 Well Protection
- 9.0 Documentation
- 10.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to define the standard method for installation and construction of monitoring wells to be followed by field personnel during the performance of a U.S. Army Environmental Center (USAEC) environmental investigation. More specifically, this SOP provides an outline of information needed to mobilize, install, and document monitoring wells based on the assumption that the objective of the program is to obtain representative ground water information and water quality samples representative of the aquifer.

2.0 Application

This SOP applies to the installation of ground water monitoring wells generally used as collection points for ground water samples and as measuring points for aquifer hydraulic properties on USAEC sites.

3.0 References

- "Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports", Department of the Army, USATHAMA, March 1987.
- "Quality Assurance Program", U.S Army Toxic and Hazardous Materials Agency, USATHAMA, Revision 0, January 1990.
- "Basic Contract - Army Total Environmental Program Support", Department of the Army, April 29, 1991.

4.0 Associated SOPs

USA-4001
USA-4010
ADL-4014

5.0 Timing and Record Submittal

- Monitoring wells shall be installed by an experienced, qualified and licensed (where applicable) monitor well driller. Monitoring well installation permits may be required in certain locations. The proposed well driller's qualifications shall be provided in the Technical Plan;
- Tentative monitoring well locations shall be determined during the site reconnaissance by the contractor, and if approved by the Government, these sites shall be immediately staked by the contractor. Well sites shall be located, where possible, in areas which are accessible by well drilling equipment. Each proposed well location shall be marked with a four (4) foot wooden stake and labeled with a well SITE ID, as required by IRDMIS. The contractor shall be responsible for determining and complying with any and all regulations, requirements, permits, drilling safety, and underground utility detection as specified;
- The source of water to be used for well installation must be approved by the PM/COR prior to arrival of sampling team onsite (Refer to "Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports", pages 4-5 for approval details). Allow three calendar weeks from the time of request for receipt by USAEC for evaluation and recommendations;

- The installation of each monitoring well shall begin within 12 consecutive hours of boring completion for holes uncased or partially cased with temporary drill casing. Installation shall begin within 48 consecutive hours in holes fully cased with temporary drill casing. Once installation has begun, no breaks in the installation process shall be made until the well has been grouted and drill casing is removed. Anticipated exceptions shall be requested in writing by the contractor to the Contracting Officer through USAEC for consideration prior drilling. Allow three working days from the time of receipt by USAEC for request evaluation and recommendation;
- Once begun, well installation shall not be interrupted due to the end of the contractor's/driller's work shift, darkness, weekend, or holiday;
- All granular filters must be approved by the Contracting Officer prior to drilling. A one-pint representative sample of each proposed granular filter pack, accompanied by the data below, III.C.5.a.(1)-(6), shall be submitted by the contractor to the Contracting Officer through USAEC for consideration prior to drilling. Allow eight working hours for evaluation and recommendation once all of the above data are received by USAEC. Each sample shall be described, in writing (see attached figure), in terms of:
 - (1) Lithology.
 - (2) Grain size distribution.
 - (3) Brand name, if any.
 - (4) Source, both manufacturing company and location of pit or quarry of origin.
 - (5) Processing method: e.g., pit run, screened and unwashed, screened and washed with water from well/river/pond, etc.
 - (6) Slot size of intended screen.
- The use of any bentonite must be approved by the Contracting Officer prior to arrival onsite of the drilling equipment (rigs). This includes bentonite (powders, pellets, etc.) intended for drilling mud, grout seals, etc. The following data shall be submitted in writing (see attached figure) through USAEC to the contracting Officer as part of the approval request. Allow six working days from the time of receipt by USAEC for request evaluation and recommendation.
 - (1) Brand name(s).
 - (2) Manufacturer(s).
 - (3) Manufacturer's address(es) and telephone number(s).
 - (4) Product description(s) from package label(s)/manufacturer's brochure(s).

(5) Intended use(s) for this product.

- The contractor shall ensure that all materials and equipment for drilling and installing a given well are available and onsite prior to drilling that well. The contractor shall have all equipment and materials onsite prior to drilling and installing any well if the total well drilling and installation effort is scheduled to take 14 consecutive days or less. ("Consecutive days" refers to the continuous combination of "working" and "nonworking days;" i.e., "calendar days."). For longer schedules, the contractor shall ensure that the above materials needed for at least 14 consecutive days of operation are onsite prior to well drilling. The balance of materials shall be either on order or in transit prior to well drilling;
- Protective casing shall be installed around each monitor well the same day as initial grout placement around the well. Any annulus formed between the outside of the protective casing and borehole shall be filled to ground surface with grout as part of the grouting procedure. Requests for exceptions in usage, design, and timing of placement will be considered on a case-by-case basis by the Contracting Officer. Request shall be made in writing prior to drilling. Include in the request the well(s) involved, reason for request, cost savings, recommendation, and alternatives. Allow six working days for evaluation and recommendation after the request is received by USAEC.
- Well construction diagrams shall be attached to the boring log and submitted from the field to the Contracting Officer's designated office within three working days after well completion.

6.0 Installation Equipment and Materials

The following equipment should be provided and maintained by the site geologist:

- A calibrated photoionization detector;
- A weighted fiberglass tape calibrated to .01 foot and of sufficient length to reach the bottom of the deepest bore hole;
- A wooden folding ruler calibrated to a .01 foot;
- An electric water meter or immiscible phase probe for obtaining water level measurements to an accuracy of .01 foot;
- A bound field notebook;

- A camera;
- A calculator;
- Flood lights for ensuring well completion;
- A sufficient supply of blank daily drilling reports, monitoring well construction field forms, and any other necessary geotechnical forms;
- A copy of the Field Operations Plan including, at a minimum, the Field Sampling Plan, the Health and Safety Plan and the Quality Assurance Project Plan; and,
- All required personnel protective equipment as defined in the Health and Safety Plan.

The drilling contractor is responsible for providing the following:

- Well screen and riser components with flush joints with square profile threads to obtain water tight seals.
- Protective well casings;
- Steel pickets to mounted radially around the well;
- Machine slotted well screens;
- Commercially available bentonite (the bentonite must be approved for use by USAEC);
- Filter sand;
- A steam cleaner;
- A 1/8 inch drill bit and drill;
- Above-ground rigid container or mixer to mechanically mix grout;
- Commercially available grout mixer/pump specifically manufactured to pump cement grout;
- Rigid tremmie pipe;

- The project specific required surface finishing materials; and
- All required personnel protective equipment as defined in the Health and Safety Plan.

7.0 Monitoring Well Installation Procedure

Once a stable bore hole has been advanced to the desired depth in accordance with Standard Operating Procedure USA-4001, the installation of a well screen and riser will proceed as follows:

Materials Inspection and Cleaning

- Typically, only polyvinyl chloride (PVC), polytetrafluoroethylene (PTFE), and/or stainless steel well screen or riser materials shall be used. All PVC screens, casings, and fittings shall conform to National Sanitation Foundation (NSF) Standard 14 for potable water usage (or American Society for Testing and Materials (ASTM) equivalent) and bear the appropriate rating logo. If a contractor uses a screen and/or casing manufacturer or supplier who removes or does not apply this logo, the contractor shall include in the Technical Plan a written statement from the manufacturer/supplier (and endorsed by the contractor) that the screens and/or casing have been appropriately rated by NSF/ASTM. Specific materials will be specified in the RFP/RFQ or proposed by the contractor in his RFP/RFQ response for the Contracting Officer's approval. All well screens shall be commercially fabricated, slotted or continuously wound, and have an inside diameter equal to or greater than the well casing. For PVC and PTFE screens, their schedule/thickness shall be the same as that of the well casing. Stainless steel screens may be used with PVC or PTFE well casing. Pipe nomenclature stamped or stenciled directly on the screen and/or blank casing within or below the bentonite seal shall be removed (via sanding);
- Inspect all materials prior to assembly to insure material integrity and cleanliness;
- All screen bottoms shall be securely fitted with a threaded cap or plug of the same composition as the screen. This cap/plug shall be within 0.5 foot of the open portion of the screen (see attached figures). No solvents or glues shall be permitted for attachment. Silt traps shall not be used.

Bore Hole Preparation

- Well screens shall be placed no more than three feet above the bottom of the drilled borehole;
- Check the total depth of the bore hole using a weighted fiberglass tape and a constant datum such as the ground surface. Bore holes that are partially obstructed by caved or blow-in sediments should be cleared in accordance with Standard Operating Procedure USA-4001 prior to initiating well installation;
- A 1.0 foot thick base layer of filter sand should be placed at the base of the bore.

Monitoring Well Pre-assembly

- Pre-cut the uppermost section of the well riser so that when the well is in place, the top of the well riser will be approximately 0.2 feet below the protective casing finished height (approximately 2.5 feet above ground surface);
- Permanently identify the survey and measuring point on the upper rim of the well riser by cutting a double notch into the rim;

Monitoring Well Installation

- Quickly assemble the well within the bore hole by adding sections to the top of the column until the screened section is set at the desired depth. Care should be taken to prevent any materials from entering the well during down hole assembly;
- Cap the well riser to prevent materials from entering the well during construction;
- Begin placing the filter pack within the annular space surrounding the well screen while simultaneously removing the augers or casing. The filter pack shall extend above the top of the screen by at least five feet, unless otherwise specified in the statement of work;
- Add the filter sand until it extends no more than 2.0 feet inside the auger or casing, then pull the casing upward allowing the filter sand to flow from the bottom, filling the resultant annular space. Frequent depth measurements should be taken using a weighted tape to verify the effectiveness of this procedure. The augers or casings should not be extracted in greater than 2.0 foot increments to minimize the potential for native sediments to cave or slump into the annular space;

- Place a bentonite seal directly above the filter pack(s) while continuing to remove the augers or casing in 2.0 foot increments. This seal should extend a minimum of 5.0 feet above the top of the filter pack as measured immediately after placement, not taking into account an allowance for swelling. Frequent depth measurements should be taken using a weighted tape to verify the efficiency of this procedure;
- In wells designed to monitor bedrock, the top of the bentonite seal shall be located at least three feet below the top of firm bedrock, as may be determined by drilling. "Firm bedrock" refers to that portion of solid or relatively solid, moderately to unweathered bedrock where the frequency of loose and fractured rock is markedly less than in the overlying, highly weathered bedrock. The interval between the top of the bentonite seal and the top of the highly weathered bedrock shall be filled with grout;
- Pour pre-approved water of a known chemistry over the bentonite pellets if they extend above the water table. Record the amount of water added during this procedure so that it can be removed during well development (USA-4010);
- Slurry seals shall be used only as a last resort, as when the seal location is too far below water to allow for pellet or containerized-bentonite placement or within a narrow well-borehole annulus. Slurry seals shall have a thick, batter-like (high viscosity) consistency with a placement thickness of five feet maximum.
- The final depth to the top of the bentonite seal shall be directly measured (via tape) and recorded.
- Grout, when used in monitor well construction, shall be composed by weight of 20 parts cement (Portland cement, type II or V) up to 1 part bentonite with a maximum of 8 gallons of approved water per 94 pound bag of cement. Neither additives nor borehole cuttings shall be mixed with grout. Bentonite shall be added after the required amount of cement is mixed with water. The mixed grout shall be recirculated through the grout pump prior to placement. Grout shall be placed using a grout pump and tremmie.
- Fill the remaining annular space with bentonite grout until undiluted grout flows from the annulus at ground surface, forming a continuous grout column from the seal to ground surface. The drill casing shall then be removed and more grout immediately added to compensate for settlement. Special attention should be made so that grout is placed prior to exposing any portion of the borehole above the seal by removal of any drill casing (to include hollow-stem augers), the annulus between the well casing and the drill casing shall be filled with grout (If

field conditions permit, the contractor may incrementally place grout and remove drill casing so as to constantly maintain 10 feet of grout (minimally) within the casing yet to be removed from the ground. Using this method requires at least 20 feet of grout to be within the casing before removing 10 feet of casing);

- After 24 hours, the contractor shall check the site for grout settlement and that day add more grout to fill any settlement depression. Repeat this process until firm grout remains at ground surface. Incremental quantities of grout added in this manner shall be recorded as added and the data submitted to the Contracting Officer through USAEC on a well diagram (or addendum);
- The top of each well installed under these requirements shall be level such that the difference in elevation between the highest and lowest part of the well casing/riser shall be less than or equal to 0.02 feet.

8.0 Well Protection

- All protective casing shall be steam cleaned prior to placement, free of extraneous openings, devoid of any asphaltic, bituminous, encrusting, and/or coating materials (except the black paint or primer applied by the manufacturer).
- Minimum elements of protection design include:
 - (1) A 5-foot minimum length of new, black iron/steel pipe extending about 2.5 feet above ground surface and set in grout (see attached figures).
 - (2) An 8 inch protector pipe for 5 inch wells.
 - (3) A 6 inch protector pipe for 4 inch wells.
 - (4) A 5 inch protector pipe for 3 inch wells.
 - (5) A 4 inch protector pipe for 2 inch wells.
- A hinged cover or loose fitting telescoping cap shall be used to keep direct precipitation and cover runoff out of the casing. All protective covers and locking caps shall be locked from the date of well installation;
- All padlocks at a given site (Army installation) shall be like-keyed. The contractor shall provide two of these keys to a Contracting Officer's designated representative at the installation and two keys to USAEC upon the conclusion of well placement;

- There shall be no more than 0.2 feet from the top of protective casing to the top of well casing. This, or a smaller spacing, is critical for subsequent water level determination via acoustical equipment;
- The protective casing, hinges, and covers will be painted orange with a paint brush (not aerosol can). White paint will be used on the orange background for the well identification/designation. This also shall be hand painted. This will be conducted and dry prior to well sampling;
- The erection of four steel pickets, each radially located 4 feet from each well, placed 2 to 3 feet below ground surface, having 3 feet minimally above ground surface with flagging in areas of high vegetation. The pickets shall be painted orange using a brush. Installation and painting shall be completed (and dry) prior to sampling the well.
- An internal mortar collar 0.5 feet within the well-protective casing annulus will be placed from ground surface to 1/2 foot above ground surface with a 1/4 inch diameter hole (drainage port) in the protective casing centered 1/8 inch above this level (see attached figure). This mortar mix shall be (by weight) 1 part cement to 2 parts sand (the granular filter used around the well screen), with minimal water for placement. Placement is required at least 48 consecutive hours prior to well development;
- Coarse gravel (3/4 inch to 3 inch particle size) shall be applied to a depth of approximately 0.5 feet in the form of a blanket extending 4 feet radially from the protective casing (see attached figures). Application is required prior to development.

9.0 Documentation

Documentation of all monitoring well installation activities including all geotechnical forms and the maintenance of a detailed field notebook will be recorded in accordance with Standard Operating Procedure ADL-4014. A well construction diagram shall be attached to the boring log and submitted from the field to the Contracting Officer's designated office within three working days after well completion. Only the original well diagram and log shall be submitted to fulfill the above requirement. Carbon, typed, or reproduced copies shall not suffice. A legible copy of the well diagram may be used as a base for the supplemental protection diagram. This well construction diagram shall graphically denote, by depth from ground surface (unless otherwise specified):

- The bottom of the boring (that part of the boring most deeply penetrated by drilling and/or sampling) and boring diameter(s);
- Screen location (top and bottom depth);
- Joint locations;
- Granular filter pack location (top and bottom depth);
- Seal location (top and bottom depth);
- Grout location (top and bottom depth); and
- Areas and depths of possible cave-in.

Protective casing and other design considerations should also be recorded. This shall include:

- A recording of the stick-up or the height of the riser without cap/plug above the ground surface;
- A measurement of the height of the protective casing without cap/cover above the ground surface; and
- Notes on size and shape of base of protective casing, drainage port location and size, internal mortar collar location, gravel blanket height and extent, and picket configuration should all be documented.

Also, a description of the following materials and specifications shall be included on the diagram or on an attachment thereto:

- A total quantity and composition of the grout, seals, and granular filter pack used for each well;
- The screen slot size (in inches), slot configuration, total open area per foot of screen, outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer;
- The outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer of the well casing;
- The joint design and composition;

- Protective casing composition and nominal inside diameter;
- Special problems and their resolutions; e.g., grout in well, lost casing and/or screens, bridging, etc; and
- Dates for start and completion of well installation.

10.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing Sections 7.0, 8.0 and 9.0 a minimum of twice under the direct supervision of a senior consultant from the Remedial Planning Unit (943) on their designee.

MONITORING WELL DEVELOPMENT

Written By:	Approved By/Date:	QA Concurrence/Date:
L. Kahn	<i>R. N. Lamb</i> 10-11-92	HILTON RIVERA 11-10-92

This SOP contains ten sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 References
- 4.0 Associated SOPs
- 5.0 Timing and Record Submittal
- 6.0 Equipment
- 7.0 Decontamination
- 8.0 Well Development Procedure
- 9.0 Documentation
- 10.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to provide geotechnical field personnel responsible for the installation or redevelopment of monitoring wells with a set of guidelines, inherent for use on U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) projects, to assure proper monitoring well development.

2.0 Application

This SOP provides a step-by-step guideline to be followed by geotechnical field personnel responsible for performing or overseeing monitoring well installation or redevelopment procedures on USATHAMA projects.

3.0 References

- "Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports", Department of the Army, USATHAMA, March 1987, pgs. 25-27.

4.0 Associated SOPs

ADL-1008

ADL-1009

Arthur D Little

USA-4012
ADL-5011
ADL-5013
ADL-5021

ADL-4014
ADL-5012
ADL-5020
ADL-5026

5.0 Timing and Record Submittal

The development of monitor wells shall be initiated no sooner than 48 consecutive hours after nor longer than 7 consecutive days beyond well installation completion. The well development field documentation forms (refer to section 9.0 of this SOP) and representative sample (refer to section 8.0 of this SOP) shall be submitted to the USATHAMA Project Manager (PM)/Contracting Officer Representative (COR) within 3 working days after development. Well development shall be completed at least 14 consecutive days before well sampling.

6.0 Equipment

The following equipment is necessary to properly develop a ground water monitoring well:

- a well key or well access equipment;
- a photo ionization detector to monitor and record volatile organic compounds present in the well headspace;
- an immiscible phase probe or chalked steel tape calibrated to a hundredth of a foot, and sufficiently long to reach the total depth of the well;
- ground water characterization equipment including calibrated pH, conductivity, temperature, turbidity, and, if required, dissolved oxygen meters;
- a solid PVC surge block;
- a bottom discharge/filling bailer or submersible pump;
- a sufficient amount of strong disposable twine equal to twice the well depth of each well to be developed if a bailer is to be used or a single well depth if a submersible pump is to be used;
- a sufficient number of DOT approved 55 gallon drums (including lids, gaskets, and fasteners) to contain all purge water, unless other water handling arrangements have been made;
- a one-pint sample bottle, including label;

- all required documentation including field books and geotechnical field forms; and,
- personnel protective equipment and decontamination equipment as specified in the project Sampling, and Health and Safety Plans.

7.0 Decontamination

All equipment which will come in contact with the well water will be decontaminated prior to arrival on site, relocation on site, and site exit. Standard Operating Procedures **ADL-1008** (for Teflon and glass) and **ADL-1009** (for metal) are to be followed.

8.0 Well Development

Upon arrival at each well, development shall proceed according to the following procedures:

- suit up in appropriate personal protective equipment as described in the site Health and Safety Plan;
- open well cap;
- monitor the headspace within the well using the photo ionization detector. This is done by placing the instrument probe at the opening of the well, and recording the reading in the field book and on the appropriate geotechnical field forms. All headspaces obtained with a photo ionization detector should be made in accordance with **ADL-5012**.
- measure and record the depth to water and depth to well bottom using a decontaminated immiscible phase probe or chalked steel tape. If free phase product exists within the well, an interface probe may be required to obtain accurate product and water levels. All measurements are to be made in accordance with **USA-4012**. Measurements are to be made to the nearest one hundredth of a foot and recorded in the field notebook and on the appropriate geotechnical field forms;
- water removal must be conducted using a submersible pump and may be supplemented with a bottom discharge/filling bailer for sediment removal and a surge block. A bottom discharge/filling bailer may be used in replace of the pump in 2-inch wells. Bailers shall not be left inside the wells post development;
- if a submersible pump is to be used for well development, gently lower the pump to well bottom at this time;

- wash the entire well cap and the interior of the well casing above the water table, using only water from that well. This shall be conducted by pumping 5 gallons of water from that well and pouring this water over the well cap and back down the inside of the well, thereby freeing the inside of the riser, well cap, and the casing between the top of the well and the water table from sediment and other extraneous materials. This washing shall be conducted before and/or during development, not after development;
- a supplementary procedure to this washing is surging the screened interval of the well. Attach one well length of twine to the surge block and lower it to the bottom of the well or just above the top of the pump, then vigorously move the surge block up and down in the well. This will create a sufficient surging action across the screened interval, thereby bringing the finer grained materials into suspension. *NOTE: It is very important to avoid contact between the surge block and the pump while performing this procedure;*
- begin to purge the well and initiate physical water quality testing for pH, conductivity, temperature, turbidity, and, if required, dissolved oxygen (**ADL-5013** for pH meter operation, **ADL-5011** for conductivity meter operation, **ADL-5021** for temperature meter operation, **ADL-5026** for turbidity meter operation, and **ADL-5020** for dissolved oxygen meter operation). These field measurements must be conducted before, twice during, and after development concurrently and recorded in the field notebook and on the appropriate geotechnical field forms;
- a minimum volumetric purge of five times the standing water volume in the well must be removed, together with any volumes referred to in the applications below. Compute the unit purge volume using the equation as follows:

$$\text{Purge Volume (Vp)} = 5 \times [\text{Well Volume (Vw)} + \text{Annulus Volume (Va)}];$$

The equation, and the necessary variable Vw and Va inputs with regard to well and well annulus measurements, can be found and the computation executed on the USATHAMA Monitoring Well Development Data Sheet (refer to **ADL-4014** for data sheet details).

In addition to this purge volume minimum, the following apply:

- a. for those wells where the boring was made by the use of cable tool, auger, or air rotary methods and without the use of drilling fluid (mud and/or water), only the five volumes **plus** five times any water used in granular filter pack placement need be minimally removed;
- b. for those wells where the boring was made or enlarged with the use of drilling fluid (mud and/or water), remove the five volumes **plus** five times any water used in granular filter pack placement **plus** five times the measured amount of total fluids lost while drilling;

- c. although in general water shall not be added to a well as part of development once the initial seal is placed, in unique circumstances approved by the COR where water is added, five times the volume of this loss shall be added to the other volumetric removal requirements;
- during development, periodically lower and raise the pump intake or bailer stopping point. This should be conducted to insure that water is being removed from throughout the entire water column;
- no dispersing agents, acids, disinfectants, or other additives shall be used during development or introduced to the well at any other time;
- purging is completed once all the following criteria have been met:
 - a. the well water is clear to the unaided eye;
 - b. the sediment thickness remaining within the well is less than 1% of the screen length; and
 - c. the proper volumetric removal, as described above, has occurred;

NOTE: should recharge be so slow that the required volume cannot be removed in 48 consecutive hours, the water remains discolored, or excess sediment remains after the five volume removal, contact the PM/COR for guidance;

- for each well, a one-pint sample of the last water to be removed during development shall be obtained and given to the installation environmental coordinator, or USATHAMA-appointed individual, for deposition within 3 working days of developing that well. Preservation of the sample is not necessary, however the sample should not be allowed to freeze;
- containerize all purge water in DOT approved 55 gallon drums, unless other handling arrangements have been made;
- upon completion of development, both the well and the purge drums are to be properly sealed and secured; and
- all drums are to be individually and permanently labeled as follows:
 - Well location designation
 - Drum contents
 - Date
 - Drum ___ of ___

NOTE: if problems are encountered during development, the PM/COR is to be contacted within 24 consecutive hours for guidance.

9.0 Documentation

Documentation of all monitoring well development activities including all geotechnical forms and the maintenance of a detailed field notebook are described in **ADL-4014**.

10.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing Sections 7.0, 8.0 and 9.0 a minimum of twice under the direct supervision of a senior consultant from the Earth Sciences and Engineering Unit (943) or their designee.

SOP No. USA-4012
Date: October 2, 1992
Revision No.: 0
Page 1 of 3

MONITORING WELL WATER LEVEL MEASUREMENT PROCEDURE

Written By:	Approved By/Date:	QA Concurrence/Date
L. Kahn	<i>R W Lank</i> 11-9-92	HILTON RIVERA 11-10-92

This SOP contains 9 Sections:

- 1.0 Purpose
- 2.0 Application
- 3.0 References
- 4.0 Associated SOPs
- 5.0 Equipment
- 6.0 Decontamination
- 7.0 Water Level Measurement Procedure
- 8.0 Documentation
- 9.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to provide sampling and geotechnical field personnel with a water level measurement procedure which will be consistent from well to well, for all U.S. Army Toxic and Hazardous Material Agency (USATHAMA) sites.

2.0 Application

This SOP will be followed every time the depth to water in a monitoring well is to be determined.

3.0 References

None

4.0 Associated SOPs

ADL-1008	ADL-1009
ADL-4014	ADL-5012

5.0 Equipment

The following equipment is necessary to properly measure the water level in a monitoring well:

- A well key or well access equipment;
- a photo ionization detector to monitor and record volatile organics present in the well headspace;
- other instrumentation as specified in the project Health and Safety Plan;
- an immiscible phase probe or chalked steel tape, calibrated to a hundredth of a foot, and sufficiently long to reach the total depth of the well; and
- all required USATHAMA documentation as identified in **ADL-4014**.

6.0 Decontamination

All equipment which will come in contact with the well water will be decontaminated prior to arrival on site, relocation on site, and site exit. Standard Operating Procedures **ADL-1008** (for Teflon and glass) and **ADL-1009** (for metal) are to be followed.

7.0 Water Level Measurement Procedure

Upon arrival at each well, the following procedures will be followed:

- Suit up in appropriate personal protective equipment as described in the Health and Safety Plan;
- open well cap;
- monitor the headspace within the well using the photo ionization detector. This is done by placing the instrument probe at the opening of the well, and recording the reading in the field book and on the appropriate geotechnical field forms. All headspace measurements obtained with a photo ionization detector should be made in accordance with **ADL-5012**;
- gently lower the immiscible phase probe down the well until the indicator light and/or tone is triggered;
- gently oscillate the probe up and down across the interface until the exact depth can be determined;
- measure the depth from the inner edge of the well riser at a point determined by the following criteria: for Arthur D. Little installed wells, all measurements will be obtained between the two notches made in the well riser (Figure 1-example A); for other wells, measurements will be taken from the high point of the riser (Figure 1-example B);

- record the following in the field notebook and on all appropriate geotechnical forms: depth to water, description of measuring point, and presence of free product; and,
- measure and record the total depth of the well using the same procedures described above.

8.0 Documentation

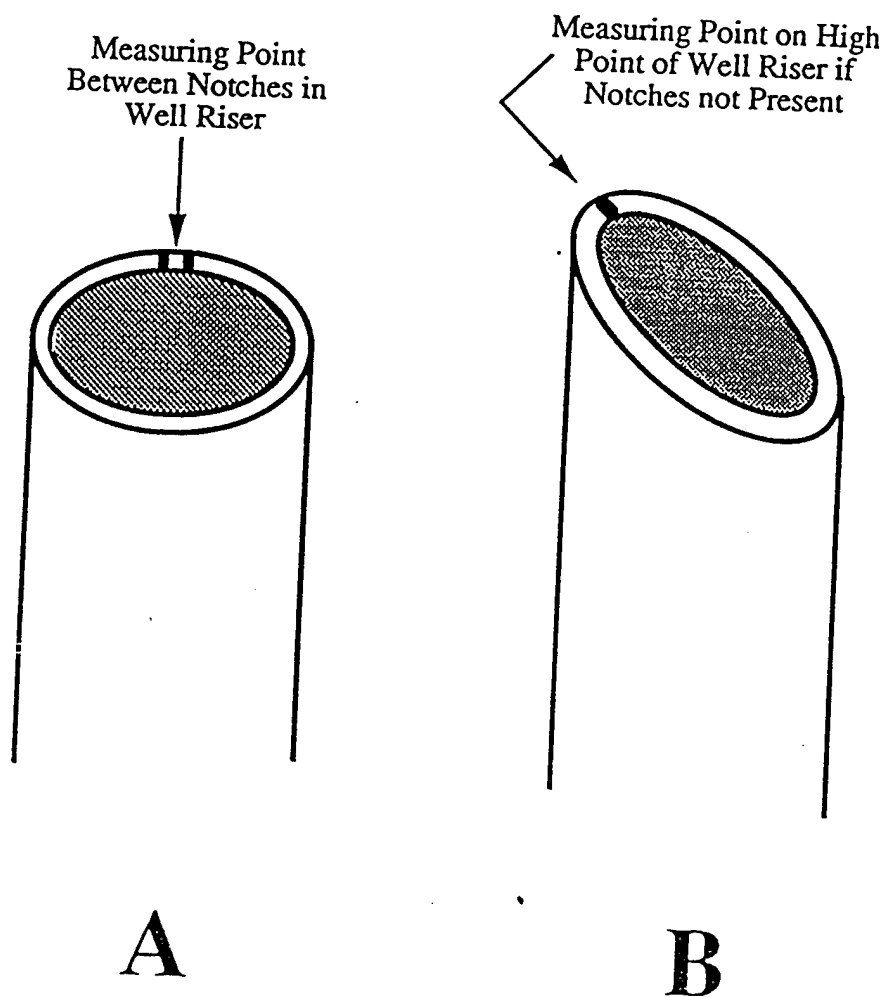
Documentation of all monitoring well development activities including all geotechnical forms and the maintenance of a detailed field notebook are described in **ADL-4014**.

9.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing Sections 6.0, 7.0 and 8.0 a minimum of twice under the direct supervision of a senior consultant from the Earth Sciences and Engineering Unit (943) or their designee.

Figure 1

Monitoring Well Measuring Points



Each of these measuring points is on the inside edge of the well riser and should be accurately described in the field notes.

SAMPLE MANAGEMENT, NUMBERING, AND LABELING OF USAEC SAMPLES

Written By:	Approved By/Date:	QA Concurrence/Date
T.Coogan	HILTON RIVERA 4/9/93	Mary Donnell Long 4/9/93

1.0 PURPOSE

This SOP provides procedures for sample management, sample numbering, and labeling, and chain-of-custody procedures for samples collected by Arthur D. Little as part of USAEC programs.

2.0 APPLICATION

These procedures apply to all samples collected by Arthur D. Little as part of USAEC programs.

3.0 REFERENCES

Quality Assurance Program, U.S. Army Toxic and Hazardous Materials Agency, January 1990.

IRDMIS Training Manual, The Installation Restoration Data Management Information System, U.S. Army Toxic and Hazardous Material Agency, September 1991.

4.0 ASSOCIATED SOPs

None

5.0 PROCEDURE

5.1 Sample Numbering and Label Production

All samples collected will be assigned a unique 8-character Field Sample Number which serves to uniquely identify the sample. The Field Sample Number will

identify the specific location at which the sample is taken, the sampling round, the source of the sample, the sample's QC status (i.e. whether the sample is a regular sample, duplicate, field blank, etc.). A ninth character will be appended to the field sample number to represent the analyses required. Field sample numbers are produced using Arthur D. Little's Sample Tracking System (STS) software. The STS software is a menu-driven program which controls the generation of Field Sample Numbers, the production of sample labels, and the production of chain-of-custody forms. The software prompts the user for the specific data required to produce the Field Sample Numbers and then prints two labels for each sample. The specific information required by the program will vary depending on the installation at the which the work is being conducted.

5.1.1 Starting the Sample Tracking System Software

- 5.1.1.1 Ensure that the Intermec 3000A Bar-Code Printer is connected to the computer's COM1 port, and that the printer is loaded with labels and turned on.
- 5.1.1.2 Change the current directory to C:\TEPSDATA by typing CD TEPSDATA at the DOS prompt.
- 5.1.1.3 Start the STS software by typing ADLSTS2 at the DOS prompt.
- 5.1.1.4 Press [F2] to start the data input module or choose **Print Sample Label** from the menu bar.

The STS prompts for information by displaying a screen in which one or more items of information must be entered. Information is entered into the system in three ways, described in Sections 5.1.2, 5.1.3, and 5.1.4, below.

5.1.2 Text Fields

Text fields are fields which require the input of plain text, such as a site identification number.

- 5.1.2.1 Select the desired field by pointing to the field with the mouse cursor and clicking the left mouse button.
- 5.1.2.2 If the system has no mouse, move to the desired field by pressing the [Tab] key until that field is highlighted.
- 5.1.2.3 Type the necessary information.

5.1.3 Pick Lists

Pick lists are on-screen boxes which display a list of choices from which one or more entries may be selected. Whenever a pick list is displayed on-screen, a default choice is always identified by a dot or an X to the left of the choice. If the default is identified by a dot, only one choice may be made from that box, such as an Installation Code or Source.

- 5.1.3.1 Using the mouse, highlight the desired choice and press the left mouse button. A dot will appear to left of the selected choice.
- 5.1.3.2 If no mouse is available, use the [Tab] key to move to the selected pick list, then use the arrow keys to move to the desired choice. A dot will appear next to the highlighted choice.

If the default choice is identified by an X, one or more choices may be selected, such as a list of required analyses.

- 5.1.3.3 Using the mouse, point to the desired choice with the mouse cursor and press the left mouse button. An X will appear to left of each selected choice. One or more choice may be selected.
- 5.1.3.4 If no mouse is available, use the [Tab] key to move to the desired pick list. Using the arrow keys, move to the desired selection and press the space bar. An X will appear to the left of each choice selected.

5.1.4 Scrolling Lists

A scrolling list is used to display choices when there are more than sixteen possibilities. Only a portion of the list is displayed at any time. The remaining choices can be displayed by scrolling the list.

- 5.1.4.1 Using the mouse cursor, point to the selected item and double click the left mouse button.
- 5.1.4.2 If your choice is not on-screen, point to the slider bar displayed on the right edge of the screen and click the left mouse button in the desired direction until the desired choice appears on-screen, then follow step 5.1.4.1, above.
- 5.1.4.3 If no mouse is available, use the [Tab] key to move to the desire scrolling list, then use the arrow keys to highlight the desired choice. Press [Enter] to select the choice.

Upon completion of all fields on a given screen, point to the "OK" button at the bottom of the screen and click the left mouse button. If no mouse is available, use the [Tab] key to move to the "OK" button, and press enter. Alternately, press the [O] key on the keyboard. At any time, the data entry process may be stopped by selecting the "Cancel" button at the bottom of the screen. Once the required information is entered into the computer, the software stores the information in the program database and prints two copies of each label for each selected analysis.

5.2 Sample Labeling

All samples collected will be labeled using the adhesive, bar-coded labels produced by Arthur D. Little's Sample Tracking System software. Each sample label will contain the unique Field Sample Number produced in Section 5.1, above, in both text and bar code formats. In addition, in plain text format, the label will identify the installation at which the sample was collected, the Media Code and File Type, Site ID, Sample Type, the required analyses, preservation, depth. Upon collection of each sample, the sampler will initial the label, and fill in the date and time of collection using waterproof ink, affix the label to the sample container, and secure the label with clear tape.

5.3 Preparing Chain-of-Custody Forms

Chain-of-custody forms are produced by the Sample Tracking System software using the information stored during the label production.

5.3.1 Starting the Sample Tracking System Software

- 5.3.1.1 Ensure that a Hewlett-Packard Laserjet Series II printer is connected to the computer's COM1 port, the printer is loaded with Arthur D. Little Chain-of-Custody paper, and that the printer is turned on.
- 5.3.1.2 Change the current directory to C:\TEPSDATA by typing CD TEPSDATA at the DOS prompt.
- 5.3.1.3 Start the STS software by typing ADLSTS2 at the DOS prompt.
- 5.3.1.4 Press [F6] to start the chain-of-custody module or choose **Print, Chain-of-Custody** from the menu bar.

5.3.2 Data Input and Chain-Of-Custody Form Production

The STS prompts for information using the same convention described in Section 5.1.2, 5.1.3, and 5.1.4, above. The type of information requested will usually vary by installation. However, the first data entry screen which requests the Field Sample Number is common to all installation.

- 5.3.2.1 Use the [Tab] key to highlight the Field Sample Number text field. Scan the Field Sample Number bar code or type the number by hand if no bar code reader is available.
- 5.3.2.2 Use the mouse cursor to point to the "ADD" button at the bottom of the screen and click the left mouse button.
- 5.3.2.3 If no mouse is available, use the [Tab] key to highlight the "ADD" button and press enter.
- 5.3.2.4 Fill in the information on the following screens:
 - Sample Date:
possible answers: a 6 character date in the format mmddyy (i.e., 010293).
 - Sample Time:
possible answers: a 4 character time in the format hhmm.
 - Sample Depth:
possible answers: a maximum of 6 characters. Refer to the USATHAMA Users Guide IRDMIS Volume II.
 - Sample Technique:
possible answers: any one in the list. If the technique you used is not listed, choose other. This will leave the sample technique column blank. You will need to refer to the USATHAMA Users Guide IRDMIS Volume II for the code.
- 5.3.2.5 When all the information has been entered for a given sample, the first screen will be redisplayed. Repeat Steps 5.3.2.1 through 5.3.2.4 above for each sample required on the same chain-of-custody form. The Arthur D. Little chain-of-custody form has spaces for fifteen (15) samples. However, filtered metals are printed on a separate line due to the required Flagging Code. Therefore, if filtered metals and any other analysis is required for a sample, that sample's chain-of-custody entry will require two lines. In

this case, the maximum number of samples per chain-of-custody form is seven (7).

- 5.3.2.6 When the information for the last sample on the chain-of-custody has been entered, select "DONE" from the Field Sample Number screen. The software will then send three copies of the chain-of-custody form to the printer.
- 5.3.2.7 Separate the three chain-of-custody forms with carbon paper for sampler(s) signature(s) and relinquished signatures. Additional information such as remarks may be hand entered on the form at this time.

6.0 PROFICIENCY MEASURE

Proficiency in this method must be demonstrated by receiving instruction and approval from an Arthur D. Little Information Management staff member. Individuals not trained in this SOP must work under the supervision of a trained staff member.

SOP USA-7006 is currently in preparation and not included in this document. Specific procedures for corrective actions for field operations are given in the Quality Control Plan.